THE UNIVERSITY OF TEXAS BULLETIN

No. 3211: March 15, 1932

SOME TEXAS FUSULINIDAE

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Bureau of Economic Geology
E. H. Sellards, Director

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The benefits of education and of useful knowledge, generally diffused through a community, are essential to the preservation of a free government.

Sam Houston

Cultivated mind is the guardian genius of Democracy, and while guided and controlled by virtue, the noblest attribute of man. It is the only dictator that freemen acknowledge, and the only security which freemen desire.

Mirabeau B. Lamar

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LIST OF ILLUSTRATIONS

This publication on Some Texas Fusulinidae has been issued in part from funds contributed to the Johan August Udden Publication and Research Fund by the North Texas Geological Society, Wichita Falls, Texas.

Those interested in this field of investigation will appreciate greatly the unselfish devotion of the author, Dr. Maynard White, who has given largely of his time in the preparation of the manuscript, and of Mrs. Helen Jeanne Plummer, who has contributed valuable editorial supervision. The publication will aid greatly in working out the geology of north-central Texas and in determining the succession of formations elsewhere.

E. H. SELLARDS, *Director*
Bureau of Economic Geology.

SOME TEXAS FUSULINIDAE

By Maynard P. White

PURPOSE AND PLAN OF INVESTIGATION

The study of Texas fusulinids was undertaken to supplement work by the author and Dr. J. J. Galloway on the fusulinids of the Ardmore Basin in southern Oklahoma. The material from the Ardmore Basin is in the process of completion for publication. As the fossiliferous outcrops in this Oklahoma area do not have a stratigraphic range higher than the Adams Branch limestone in Texas, fusulinids from this geologic position upward to the base of the Permian were sought in north-central Texas.

Work on this group of foraminifera was undertaken for practical economic reasons, and the primary purpose of this paper is to place before the reader as complete a set of data pertaining to each form as is possible. Special emphasis has been placed on those shell characters that lend themselves to precise measurement, in order to reduce to a minimum the element of human error. By doing so it is hoped that the forms described can be readily recognized whether or not certain ideas of development, classification, and nomenclature held by the author are accepted.

The attempt has been made to avoid further complication in this group of fossil species both in nomenclature and in number of species. In keeping with this purpose the number of generic names has been kept to a minimum of three, *Fusulina, Triticites,* and *Schwagerina.* In view of the need of revision of the nomenclature, due to the recent recognition of the true status of *Fusulina,*[1] it is hoped that this paper will help to establish a simpler nomenclature than has been used in the past and than has been suggested for the future.

The necessity of fine distinctions for the best results in practical application in subsurface correlations is recognized. It is felt, however, that many of these fine distinctions are best left to the individual worker and should be based on well-defined and easily recognized genera and species. So far as is practicable, questions

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[1]Dunbar, C. O., and Henbest, Lloyd G., The fusulinid genera *Fusulina, Fusulinella,* and *Wedekindella:* Am. Jour. Soc., ser. 5, vol. 20, pp. 357–364, 1930.

of relative amount and degree should not become the basis for generic distinctions, especially those that involve descriptive expressions to which different individuals would almost certainly assign different values. Those definite characters which by their presence or absence have precise values, at least for generic distinctions are salient.

ACKNOWLEDGMENTS

The author is indebted to the Gypsy Oil Company, for whom this study was made, for permission to publish the results. From Mr. F. B. Plummer, Mr. M. E. Upson, Dr. Gayle Scott, and Mr. Fielding Bohart the author has received material, and the first two gentlemen have been very helpful guides in making field collections. The author is indebted to Dr. Marcus Hanna for the photomicrographs on Plates 9 and 10, and to Mrs. Helen Jeanne Plummer for careful editorial supervision and much constructive criticism.

WALL STRUCTURE

The diagrammatic sections of fusulinid wall structures in figure 1 show the developmental stages of these forms from the primitive *Fusulina* through the highly developed *Triticites* (formerly called "*Fusulina*") and the various characters of these walls as interpreted by the author.

By *fibers* is meant the parallel filaments that comprise the walls of the individual tubes; as seen in thin section these fibers appear as parallel lines. The tectum of all tests and all portions of the walls of the lower forms are composed only of fibers. By *alveoli* is meant groups of fibers into bundles that are pendant from the inner surface of the tectum of the higher forms and appear at first sight to comprise large single tubes in the keriotheca.

Thin sections of the coarser walls of the higher forms show that the spacing of the fibers is related both to position in the individual test and to the evolutionary stage of the species. In a given test the fibrous structure is progressively coarser from the innermost volution outward and from the most primitive to the advanced forms, though in any definite part of an individual test this spacing is not necessarily exactly uniform. In some parts of a shell wall fibers are so much more widely spaced than the average, that these wide intervening spaces constitute what are here called *pores*. Such pores may be present or absent in different tests of the same species and are in general more prevalent in the outer volutions of geronitic forms, as would be expected.

In very thin sections of later forms of *Triticites* where thickness of wall and coarseness of fibrous structure gives most assurance of

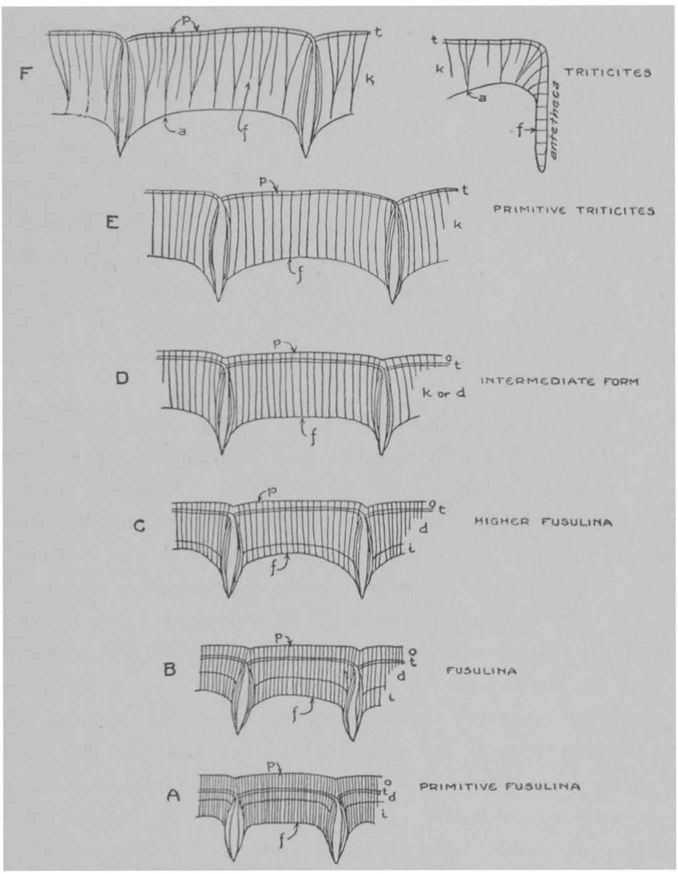

Fig. 1.—Diagrammatic sections of shell walls of various types of fusulinid tests arranged to show their upward stratigraphic sequence.

o, Outer depositional layer or outer tectorium
i, Inner depositional layer or inner tectorium
t, Tectum
d, Diaphanotheca
k, Keriotheca
f, Fibers
a, Alveoli
p, Perforations

clear observation of fine details, the antetheca is found to consist wholly of a fibrous perforate tectum slightly thicker than the tectum of the spirotheca of the same chamber but thinner than the average septum of the test.

TAXONOMIC IMPORTANCE OF SHELL WALL

The Fusulinidae have established themselves as important index forms, though work on them has hardly more than begun. Much difference of opinion exists as to their true character and their plan of development, a correct understanding of which is essential to their proper classification and utilization in stratigraphic studies. A resumé of the features that form the basis of the classification of all foraminifera and their application to the Fusulinidae may help greatly in weighing the merits of the various interpretations of their shell characters and the theories regarding their development. These fundamental features serve to connect all forms and to make of each form a unit in a long connected evolutionary scheme.

Three morphological characters form the foundation of any satisfactory classification into families and subfamilies in accordance with the biogenetic law as defined by Hyatt. This law states that each individual in its life history (ontogeny) repeats successively the stages through which its ancestors passed in the evolution of the race (phylogeny). In other words, the youthful stages of one genus are like the adult stages of its ancestral form. The first morphologic feature used in distinguishing families and subfamilies, and first in importance in distinguishing genera, is the material and character of which the test is composed. The second feature is the arrangement of the chambers in the test and the resultant form of the test. Third in importance is the character of the aperture (simple or multiple), if present. Surface features, such as striations, plications, spines, knobs, and other minor markings do not constitute generic, but rather specific or varietal, characters. Throughout the following discussion the reader is asked to keep the above features in mind, to weigh each point in terms of these, and to fit them into the connected evolutionary scheme based on Hyatt's law.

Two opposing conceptions of the shell structures in the Fusulinidae prevail, as follows:

1. That which is supported in this paper regards all forms as perforate and as possessing either alveoli or fibers. This is essentially the interpretation by Carpenter, Möller, Schwager, Verbeek, and Schellwien.
2. The opposing interpretation regards all forms as imperforate, the lower forms as lacking in alveoli or fibers, and the higher forms as possessing alveoli, which do not penetrate the tectum.

Corollary to these conceptions is that by the first no external aperture exists, whereas by the second an external aperture is recognized.

These fundamental differences in the two lines of thought are of greater importance than may at first seem apparent. In the first place, the imperforate test postulated by one group of workers makes the Fusulinidae the one exception to the biogenetic law that expresses the controlling force of evolution in foraminifera as well as in other biologic groups. Such a wall character denies this law by not recognizing the progressive development implied therein. By doing so it becomes necessary to elevate to unwarranted importance such minor features as fluting, filling, chomata, and shape. The recognition of a perforate test involves no such denial of the biogenetic law nor the necessity of disregarding the character of the shell wall in establishing the connected scheme of evolutionary development. The genera, as will be understood more clearly later, based upon the first interpretation, not only meet the requirements of the biogenetic law and stress the features regularly used in classification in order of their importance, but they involve no stressing of recurrent morphologic characters. This plan simplifies the classification and answers more closely to stratigraphic restriction. For example, filling occurs amongst the early forms of *Fusulina*,[2] disappears later, and recurs among late forms of *Triticites*. Before the correct definition of *Fusulina* was established, *Triticites* was differentiated from "*Fusulina*" by strong chomata and relatively little fluting, as compared with strong fluting and very weak or no chomata in the latter. *Triticites tumidus* Skinner, however, possessing about the strongest chomata known, occurs with *Schwagerina*. *Triticites ventricosus* (Meek) var. *inflatus* Galloway and Ryniker n.sp. (m.s.), generally not granted even a varietal position, might even be assigned to a new genus, since it is rather

[2]*Fusulina* is here used in its true sense, as recently defined by C. O. Dunbar and Lloyd Henbest (see footnote 1).

strongly fluted and possesses marked chomata. Among the *Fusulinae*, *F. tomlinsoni* Galloway and M. P. White n.sp. (ms.) is a stratigraphically younger form than *F. mirabilis* Galloway and Ryniker n.sp. (ms.), yet the former has practically no fluting and the latter is strongly fluted. As the early stages of any individual are more highly fluted than the later stages, assuming that fluting is a substantially dependable character, according to the biogenetic law all primitive forms should be strongly fluted. All highly developed forms should therefore be very slightly fluted or not fluted at all, a condition contrary to observation. These and further contradictions to accepted biologic principles, necessitated by discarding so fundamental a character as progressive evolution of the wall structure and by stressing the importance of minor characters, must lead either to a denial of the biogenetic law or, as has been done, to erecting many new genera.

The proponents of the imperforate test have been aware of the confusion that their interpretations create and of its violation of taxonomic rules. To quote Dunbar and Condra:[3] "Some, like Schwager, were led to classify '*Fusulinella*' (*Staffella*) far from the fusulinids, while others, like Schellwien, were forced to discount the taxonomic value of shell porosity" by accepting such a theory.

Observations that support the interpretation accepted by the author show that all forms possess either fibers or alveoli, that these penetrate all portions of the outer walls, and that all tests are therefore perforate. These alveoli or fibers have been observed in thin sections of all species of the Fusulinidae, and they penetrate all portions of the wall (Pls. IX and X). Sizes range from ten fibers in .040 mm. in the most primitive to ten alveoli in .260 mm. in *Schwagerina* as measured in the last whorls. The exceeding thinness of the tectum makes it very difficult to distinguish this layer at all, and the penetrating fibers are still more obscure. Not only can they be observed, however, but their existence through this layer can also be established in the lower forms by their presence on both sides of the tectum—that is, across the outer depositional layer (outer tectorium) and the diaphanotheca. In the higher forms

[3]Dunbar, C. O., and Condra, G. E., The Fusulinidae of the Pennsylvanian system of Nebraska: Neb. Geol. Survey Bull. 2, ser. 2, p. 21, 1927.

this fibrous structure is present in the chomata, or a portion of it, and in the keriotheca. The coarseness of the fibers or alveoli in the more advanced forms makes detection easier, and thin sections of the antetheca show it to consist solely of a fibrous perforate tectum (Pl. X, figs. 3, 4). Observations of the exterior surfaces of such higher well-preserved tests show the presence of the open ends of these tubes over the entire surfaces of perfect specimens (Pl. IX, figs. 1, 2).

Dunbar and Condra[4] have called attention to the following observations in support of the interpretation of shell structure accepted in this paper, though they deny the conclusion to which these observations point:

> The correct understanding of the structure of the inner wall of *Fusulina*[5] tended rather to increase than to solve the dilemma for it is less difficult to conceive how a compact wall could develop porosity than to imagine how a simple, structureless layer could assume the extraordinary complexity of a keriotheca. Now the possibility arises that the diaphanotheca of the Fusulinellinae is really a keriotheca but one with a texture too fine to be readily recognized. The following considerations seem to support this deduction.
>
> (1) In the earlier species of *Fusulina* and *Triticites* the texture of the honeycomb layer is in some cases so fine as to be distinguished with difficulty.
>
> (2) Even in the later species of these genera, as *T. secalicus* or *T. ventricosus,* the lamellae are so fine near the outer edge of the shell, before any fusion takes place, that the "dark lines" of the sections generally seem to disappear before reaching the tectum. We know in this case that the whole structure hangs upon these invisibly fine lamellae, but if it were not for the thicker, lower portions of the lamellae, they would almost certainly have been overlooked.
>
> (3) The fact that the lamellae always begin as almost invisibly fine structures, and with growth come to fuse or thicken, may be looked upon as an ontogenetic feature pointing to ancestors wherein the lamellae were of the finest type.
>
> (4) The series *Neoschwagerina, Yabeina, Sumatrina* shows a perfect parallel among the higher fusulinids.
>
> (5) While no specimens of *Staffella* are available for our study, sections of typical *Fusulinella girtyi,* when examined under a magnification of about 150 diameters, show that the inner wall is not really homogeneous. Although the structure is so nearly on the limit

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[4]Dunbar, C. O., and Condra, G. E., op. cit., pp. 21 and 22.

[5]*Fusulina* as used before the true character of the genus had been correctly determined by Dunbar and Henbest, 1930.

of visibility that it is impossible to be certain, its appearance lends considerable support to the four lines of evidence listed above.

It should be added that the texture of the lamellae themselves is not that of a compact homogeneous plate as Schellwien's figures would suggest. Our best and thinnest sections when studied under a magnification of 200 diameters indicate that the lamellae are constructed of loosely laid spicules or granules of calcite, the whole strongly suggesting, in miniature, a very rough, coarse stone wall laid up without mortar.

When the wall is followed back toward the initial or embryologic chamber it is found that the keriotheca gradually decreases in thickness until in its earliest volutions it can not be distinguished. As Dyhrenfurth has pointed out, this may be considered an ontogenetic character pointing to ancestors whose shell wall consisted of the tectum alone.

This discussion carries the suggestion, which has from time to time been amplified and more definitely stated, that the ever-present fibrous or alveolar structure is but a pseudo-fibrous or pseudo-alveolar structure due to partial recrystallization, or it is a system of crystal margins or fractures. Such an interpretation is untenable because of the evolutionary character expressed by increase in size or in coarseness both in phylogenetic and ontogenetic development. It is impossible to concede that mineralogic structure is influenced either by geologic age or by position within the individual. In other words, it is not seriously to be considered that this structure, if mineralogic, should be consistently finer in more primitive forms, and it is still less likely to be consistently finer in the earlier stages of the same individual. Further, why should it be equally true of forms replaced by amorphous silica? The undebatable evidence of the existence of these fibers beautifully preserved in silicified specimens from the lower fusulinid bed of the Marble Falls formation in Texas, the lowest known fusulinid, has led to its identification as a species of *Triticites* by some workers.

On the basis of apertural characteristics the existence of perforations can be proved. For reasons too obvious to require discussion, a test can be perforate with external aperture (or apertures), perforate without external aperture, or imperforate with external aperture; no test can be imperforate without external aperture. Thus it naturally follows that if *Fusulina* and *Triticites* have no external aperture, they must be perforate. Pores in no way confuse the issue, since they may be present or totally absent in different individuals of the same species. Naturally so uncertain an occurrence of this feature in the shell structure obviates any argument that such a structure permits the existence of an imperforate test without external aperture. Of the many specimens examined by the author and other workers in the same area, tests with sufficiently well-preserved antetheca to allow precise observations have exhibited no apertural opening, nor has any evidence of an original aperture been found. Illustrations of tests showing the antetheca reaching down to the wall of the preceding whorl are Pl. II, figs. 6*h* and 9*i*; Pl. III, figs. 10 *d* and 13*c*, *d*; Pl. IV, figs. 2*h*, *i* and 15 *g*, *l*; Pl. V, figs. 5*e*–*g*, *j* and 15*b*, *e*; Pl. VI, figs. 2*c*, *d*, *f*, *h*, 5*a*, *b*, 9*a*, *d*–*f*, *i*, and 12*a*–*c*, *e*; Pl. VII, figs. 1*b*, *d*, *f*, *i*, 12*e*, and 15*f*, *g*, *h*. An external aperture in these forms is supposed to be located between the chomata. In all median sections across a well-preserved final chamber the antetheca is found to extend completely down to the wall of the previous whorl, thus precluding the possibility of the existence of an aperture. Since the chomata are less prominent in later chambers than in the preceding ones, and the last tunnel angle in some thin sections is unusually small, it appears that the chomata may be constructed during life by the bilateral accumulation of shell material that is removed from this wall after it ceases to be the antetheca and has become a septum.

The recognition of a perforate shell allows the fundamental character of the wall with its various structural features, such as size and character of tubes, component parts with their presence or absence and relative thickness, the thickness of the whole wall structure, and height of volution, to assume their proper taxonomic position. Minor features such as fluting, chomata, filling, and shape are thus relegated to their proper position. Such a plan of procedure results in a more logically connected scheme of classification with fewer genera, each of which is not only more valid but more intelligible, and further they are more stratigraphically significant. By evaluating and weighing each feature of the individual in terms of the other features and of the whole, each species becomes but a link in a long chain, not a unit in a haphazard assortment. In this connection it is helpful to conceive of an ever-present urge toward perfection of these structural investments for the necessary functions that they serve in the life of the individual and set to the principle of a certain economy of accomplishment. What this urge is and how it operates is a long and debatable question, but its existence is little doubted.

The relative precision of descriptive expressions for the secondary characters of a test as compared with the mathematical precision that can be employed in measuring the features of the fundamental shell wall is a salient consideration. Such secondary features as fluting, chomata, and shape, other than expressed simply as form ratio, do not lend themselves to exact expression in mathematical terms. Not only is it hard for anyone to convey accurately to another just what is meant by "strong" or "weak" (for fluting or chomata), by "ventricose" or "inflated," but even on the basis of some standard of comparison any worker is likely to describe the same individual test differently at different times. Such terms are relative and increase the element of human error, which should always be kept to a minimum. Furthermore such features as fluting vary greatly, for they depend on just where the thin section happens to cut the flutings even in properly oriented sections through the center of the test. Not only are the character and structure of the shell wall more important, but these features lend themselves to numerically commensurable expression. Descriptions should be as complete as possible, especially for those features that do not require interpretation and that involve the element of human error beyond that of measurement. Too often only one angle, only one thickness, only one height of volution is recorded without designation as to where taken.

The progressive phylogenetic development of the fundamental shell structures in fusulinids and changes in shell porosity in certain parts of the shell wall during individual growth are shown in figure 1. The uppermost section shows the thickened fibrous and perforate tectum that forms the antetheca. The perforate character of the antetheca was lost some time after it ceased to be the antetheca and became one of the septa. In general the later septa in any shell retained their fibrous character, and rarely portions of the early septa are fibrous. After the tunnel had been formed, there was no longer need of porous septa, and the perforations probably became filled with depositional material. In other portions of the wall that must maintain porosity, subsequent material deposited on the tectum was made perforate by growth of the tubes through the depositing material. Only in excessively thick depositional material of the chomata was the maintainance of the perforate character sometimes lost.

The genus *Fusiella* is supposed to be a primitive form whose wall consists only of a very thin tectum and relatively thick inner and outer depositional layers (tectoria) without a diaphanotheca. It is the author's opinion that no such wall exists in the forms to which it is accredited. It would seem safe to assume *Schubertella,* still in possession of the endothyroid stage, to be its ancestor, yet *Schubertella* has no such wall structure. All primitive forms of *Fusulina* examined by the author, including so-called *Fusiella,* like *Schubertella,* possess a thin diaphanotheca. Such a wall structure as has been assigned to these primitive tests called *Fusiella* seems to have resulted from the failure to observe the thin diaphanotheca or to separate it from the thin tectum. From this early *Fusulina* with its very thin tectum and its relatively thick depositional layers, by both the actual and relative increase of thickness of the diaphanotheca with at least a relative decrease in thickness of the depositional layers is developed the more typical form of *Fusulina.* This development of the wall continues progressively into the higher forms of *Fusulina,* where the diaphanotheca comprises most of the wall, and finally into the intermediate phylogenetic stage between *Fusulina* and *Triticites,* where only one of the depositional layers (outer tectorium) is left. In tests belonging to this intermediate stage the early or youthful volutions of the individual belong to the typical *Fusulina,* the following volutions are of the median type, and the last ontogenetic stage of coiling shows the wall structure typical of a primitive *Triticites.* This transition form with its three-layer wall is analagous to *Fusiella,* but instead of having a tectum and two depositional layers, it has a tectum, diaphanotheca or keriotheca, whichever term be preferred, and one depositional layer. Further, it is not a primitive *Fusulina* but rather an intermediate stage between the four-layer form, *Fusulina,* and the two-layer form *Triticites,* and occupies a corresponding stratigraphic position. The next phylogenetic stage may be called triticitian, in which the wall consists of but two layers, the tectum and the diaphanotheca, or as it is generally called in this paper, the keriotheca. The wall structure of this primitive *Triticites* differs from the fully developed and typical *Triticites* in that the tubes are still bound by fibers that have not converged inward to form true alveoli, a feature characteristic of the higher forms of *Triticites* and of *Schwagerina.* In tests of these two last-mentioned forms the parallel fibers of the tectum on entering the keriotheca converge into groups of two or more, and adjacent groups are separated by one or more fibers that appear to extend but a short distance into the keriotheca. Near the outside of the keriotheca the proximity or combination of the walls of these tubes makes for the dark lines or alveoli (two or more fused fibers), which appear on superficial observation to be suspended from nothing at some distance below the tectum. This is a deception; when the thin section is thick enough to show alveoli best, it is too thick to show the fibers that have not combined. It should be remembered that from the most primitive test upward in the evolutionary column these tubes become progressively coarser or greater in diameter, as well as from the early to later whorls of an individual, a feature particularly marked in the higher forms, because the coarser texture of the alveolar tubes presents more clearly such fine structural details. Not only do the various portions of the wall change in the fashion shown with accompanying coarsening of tubes, but though composed of fewer layers, in general the higher forms exhibit an ever-increasing thickness of the wall as a whole. This thickening has apparently been denied for the *Schwagerinae.* This apparent, but not actual, denial is an illusion that arises from the sudden great increase in height of volution as compared with the more gradual increase in thickness of the wall. Throughout the series of lower forms the height of volution and wall thickness maintain a more uniform ratio. The actual wall thickness in *Schwagerina* shows a definite increase.

Any simple evolutionary progression such as outlined here is not absolute. Minor variations and exceptions occur, and these are due to unusual effects of secondary characters. Such exceptions, however, do not detract from the value of the general controlling plan, especially if the causes of the exceptions are noted and evaluated. Though the sketches in figure I are purely diagrammatic, they illustrate the salient points in this plan of grouping fusulinid tests.

Since the fusulinid wall structures occurring in the geologic column show progressive development of details that can be readily observed in thin section, this simple plan of classification meets well the needs of the stratigrapher. On this basis *Schubertella* (not recognized in the series of Texas species treated in this paper) is understood to be that form possessing an endothyroid initial stage and a four-layer wall composed of inner and outer tectoria, diaphanotheca, and tectum. *Fusulina* comprises tests of the same wall structure but lacks the endothyroid primordial stage. *Triticites* is the name applied to a fusulinid test the wall of which consists of only the tectum and keriotheca and in which the successive chamber cavities increase gradually. *Schwagerina* is characterized by the same simple double-wall structure, but the thickness of the chamber cavity following an early stage increases abruptly and in some forms decreases again in the last stage of coiling. Not the least of the points lending assurance to the validity of such a classification is the very existence of intermediate phylogenetic stages between typical *Fusulina* and typical *Triticites,* stages for which generic names are not yet needed, as such tests have not as yet been described in the literature. It is not meant that these features alone constitute sufficiently complete descriptions of these genera. But by their acquirement and loss, never to be lost or acquired again, they are sufficient in themselves to separate the generic groups without question or difficulty.

It is unfortunate, but inherent in the very nature of a species, that absolute limits through the loss or gain of non-recurrent characters as here employed for genera can not be extended to the grouping of specific characters. With sufficiently complete data, however, the relative position of any form between (and it is always between) two properly described species can be determined. Figure 2 illustrates a card index system that has proved very helpful in comparing forms. The arrangement of data from left to right expresses both convenience in the order of making laboratory observations and also to some degree the relative importance of the successive features.

It must be acknowledged that the acceptance or rejection of the interpretations given depends greatly upon the ability of the observer to see in thin section the various shell characters employed by this plan. It must be granted that observation of finer details is difficult, that the number of specimens in the possession of one worker may be much greater or fewer than that in the possession of another. High powers of magnification and strong illumination are likely to defeat their very purpose by obliterating contrast, a very important factor in these investigations. Certainly successful observation requires well-preserved specimens and properly ground thin sections.

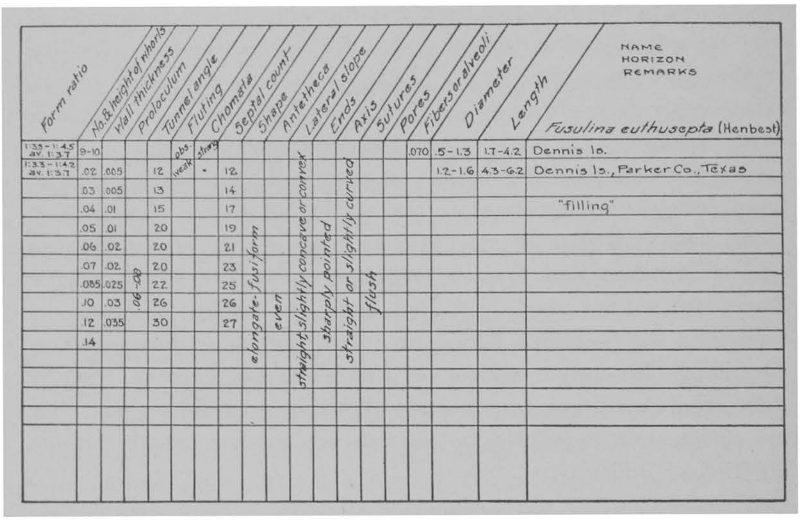

Fig. 2.—Card form for data on each species of fusulinid at each collecting locality.

DESCRIPTIONS OF LOCALITIES

Since working the original collections more material has come to hand which might have been added to the series already treated in this paper. Specimens in some abundance have been collected from the Black Ranch limestone near the top of the Thrifty formation, but the preservation, due mainly to crushing, makes the material too poor to work. Other collections consist of material in poor preservation or of too few specimens, or they come from stratigraphic positions already represented by species described from better outcrops.

Brewster County

Sta. 22–T–139. One mile west of Ramsey (old Taylor) ranch house in the westernmost foothills that parallel the main escarpment of Glass Mountains and north of Wolf Camp. Specimens collected by M. E. Upson from these strata in the lower Wolfcamp formation include *Triticites longissimoideus* (Beede), *Schwagerina gigantea* M. P. White, n.sp., and S. *uddeni* Beede and Kniker. This is the type locality for the Wolfcamp formation, from which fossils have been listed and described by J. A. Udden[6] and by R. E. King.[7]

Callahan County

Sta. 30–T–15. Just east of Chautauqua the Coleman Junction limestone, top of Putnam formation, yields *Triticites emaciatus* (Beede) var.? in abundance. (Collector, M. E. Upson.)

Coleman County

Sta. 42–T–33. Shale below the Crystal Falls limestone, base of Harpersville formation, 2.85 miles by road southwest of Rockwood on the Brady road, carries *Triticites obesus* (Beede). (Collector, Gayle Scott.)

Sta. 42–T–34. About one and one-half miles southwest of Rockwood the Waldrip beds (probably the equivalent of the Belknap limestone), Harpersville formation, carries *Triticites obesus* (Beede). (Collector, M. E. Upson.)

Eastland County

Sta. 67–T–25. At top of hill about one mile south of Lake Cisco dam on Cisco-Moran road, at a point 2.8 miles by road from the Cisco depot, the Saddle Creek limestone, Harpersville formation, is rich in *Triticites ventricosus* (Meek) var. *inflatus* Galloway and Ryniker n.sp. (ms.).

Jack County

Sta. 118–T–1. Railroad cut under viaduct over Gulf Texas and Western Railroad 3.4 miles by road southeast of the courthouse in Jacksboro on the highway to Mineral Wells. On both sides of the viaduct the outcrop of Jacksboro limestone, top of the Caddo Creek formation,[8] yields in large abundance *Triticites acutus* Dunbar and Condra, *T. consobrinus* Galloway and Ryniker n.sp. (ms.), and *T. cullomensis* Dunbar and Condra.

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[6]Udden, J. A., Notes on the geology of the Glass Mountains: Univ. Texas Bull. 1753, pp. 1–59, 1917.

[7]King, R. E., The geology of the Glass Mountains, Pt. II: Univ. Texas Bull. 3042, pp. 1–245, pls. 1–44, 1930.

[8]Recent field work by F. B. Plummer and Joseph Hornberger has resulted in a slight adjustment in the original geologic section (Univ. Texas Bull. 2132) in this area. The Jacksboro limestone lentil and the underlying 75 feet of strata in the central and eastern portions of Jack County have been found to be approximately equivalent to the Home Creek limestone, which is persistent from the southwestern corner of Jack County southwestward across the area of the Pennsylvanian outcrops. Accordingly, the Jack County map, published by the Coöperative Mapping Commititee (Bureau of Economic Geology) shows the Jacksboro limestone at the top of the Caddo Creek formation and at the top of the Canyon group.

Species of smaller foraminifera have been described by Cushman and Waters[9] from this locality.

Sta. 118–T–8. Railroad cut under viaduct over Rock Island Railroad 3.7 miles by road southeast of the courthouse at Jacksboro on the highway to Mineral Wells. The steep bank exposes the *Campophyllum* limestone of the upper part of the Caddo Creek formation in the base of the exposure on the west side of the viaduct and the overlying ten feet of shale in the base of the shale member between this limestone and the Jacksboro limestone ledge in the railroad cut at Sta. 118–T–1. The strata in the top of the slope carry in abundance tests of *Triticites acutus* Dunbar and Condra and *T. obesus* (Beede).

Species of smaller foraminifera have been described by Cushman and Waters[10] from this outcrop. A list of the large fossils occurring here has been given by Plummer and Moore.[11]

Palo Pinto County

Sta. 181–T–6. About three and one-half miles by road west of Millsap and about one and one-half miles by road northeast of Goen Cemetery on the Millsap-Gordon road in the eastern edge of Palo Pinto County, the Gordon limestone, Millsap formation, carries in abundance *Fusulina haworthi* (Beede) and *F. meeki* (Dunbar and Condra) var. *similis* (Galloway and M. P. White), n.var. (ms.). This stratigraphic position is about 14 feet below the Thurber coal (top of Millsap formation) and about 220 feet below the Brazos River conglomerate.

Sta. 181–T–14. In a bluff in Metcalf Gap, 3.2 miles by road west of Wink City and about two miles east of Brad on Texas Highway 1A, *Triticites irregularis* (Schellwien and Staff), first form, occurs in abundance in the Brownwood shale member of the Graford formation 60 feet below the base of the Adams Branch limestone.

Sta. 181–T–41. Mineral Wells Crushed Stone quarry about three miles east-southeast of Oran exposes the upper strata of the Palo Pinto limestone, which attains a much greater thickness southwestward. In a shale seam in the quarry face *Triticites irregularis* (Schellwien and Staff), second form, is abundant. The third form of the same species occurs abundantly in the top of the limestone on the south side of the quarry.

Sta. 181–T–43. About a thousand feet north of the road in front of Union School, six miles north and a little west of Mineral Wells, the Keechi Creek shale member of the Mineral Wells formation at a stratigraphic position from 60 to 75 feet below the base of the Palo Pinto limestone yields in abundance *Triticites irregularis* (Schellwien and Staff), fourth form.

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[9]Cushman, J. A., and Waters, J. A., Foraminifera of the Cisco group of Texas: Univ. Texas Bull. 3019, p. 24, 1930, Sta. C-4 and Sta. C-5.

[10]Cushman, J. A., and Waters, J. A., op. cit., p. 24, Sta. C-6.

[11]Plummer, F. B., and Moore, R. C., Stratigraphy of the Pennsylvanian formations of north-central Texas: Univ. Texas Bull. 2132, p. 138, 1921.

Sta. 181–T–79. About one mile in direct line northeast of Mineral Wells, in the East Mountain shale member of the Mineral Wells formation just below the Lake Pinto sandstone *Triticites irregularis* (Schellwien and Staff), fourth form, and *T.* sp. A are rare forms. (Collector, F. B. Plummer.)

Parker County

Sta. 183–T–6. At Dennis a shaly seam in the top of the Dennis limestone, Millsap formation, carries *Fusulina euthusepta* (Henbest) and *F. meeki* (Dunbar and Condra). (Collector, M. E. Upson.)

Pecos County

Sta. 185–T–3. At Gap Tank, Glass Mountains, material collected by Fielding Bohart from the upper Gaptank formation includes *Triticites compactus* M. P. White, n.sp., *T. compactus* M. P. White, n.sp. var.? (from an ant-hill), T. *emaciatus* (Beede), *T. tumidus* Skinner, *T. longissimoideus* (Beede), and *Schwagerina fusulinoides* Schellwien (from an ant-hill).

Sta. 185–T–12. Between two and one-half and three miles southeast of Gap Tank, Glass Mountains, in the southeasternmost exposure of Pennsylvanian strata in this area, (east-central side sec. 18, H. & T. C. Ry. Blk. 2) the lower Gaptank formation yields in abundance *Triticites irregularis* (Schellwien and Staff), fourth form. (Collector, M. E. Upson.)

Stephens County

Sta. 214–T–2. About two and one-half miles southwest of Ivan the second prominent escarpment along the highway to Breckenridge is rich in fusulinids. The road lies approximately on the top of the upper Gunsight limestone ledge. The shale about five feet above the road level, Thrifty formation, carries *Triticites ventricosus* (Meek) in abundance and *T. beedei* Dunbar and Condra var.? as a rare form. About 70 feet higher in the slope and 20 feet below the capping Ivan limestone three forms occur together in abundance, *T. ventricosus* (Meek), *T. ventricosus* (Meek) var. *meeki* (Möller), and *T. beedei* Dunbar and Condra.

Sta. 214–T–23. In the first escarpment about one-quarter mile southwest of Ivan and about one hundred yards north of the Ivan-Breckenridge road *Triticites secalicus* (Say) is abundant at the base of the shale between the upper and lower Gunsight limestone layers of the Graham formation.

Sta. 214–T–24. On the Breckenridge-Albany highway 6.7 miles by road west of Burch Hotel in Breckenridge *Triticites ventricosus* (Meek) is rare in a limestone that is probably the Saddle Creek limestone member of the Harpersville formation.

Young County

Sta. 251–T–2. About one mile west of Graham near the top of a 100-foot steep slope just below a small dam on Salt Creek and about one-quarter mile upstream from the bridge on the Graham-Breckenridge highway the Gunsight limestone, Graham formation, is overlain by a few feet of shale and the Avis conglomerate and is underlain by nearly 80 feet of shale. Just below this ledge of Gunsight limestone *Triticites moorei* Dunbar and Condra, *T. plummeri* Dunbar and Condra, and *T. plummeri* var.? occur together in abundance. This is the type locality for these species.

This exposed section has been measured by Plummer and Moore,[12] and they have listed the names of megafossils from both the shale above the Gunsight ledge and the shale below. Several species of smaller foraminifera from these shales have been described by Cushman and Waters.[13]

Sta. 251–T–26. At the junction of a small creek and Brazos River along the north bank of the river about one-half mile downstream from Brazos River bridge on the Graham-South Bend road, *Triticites* sp. B is rare at about the contact of the Gonzales Creek shale and the Bunger limestone, Graham formation.

DESCRIPTIONS OF SPECIES

It is sometimes said that specific determinations should not be made without comparison with the holotype (or cotypes) or at least with topotypes. This would make identification impossible for most workers. The better requirement would seem to be that which calls for differences in such characters as lend themselves readily to description and measurement. These characters should in themselves define a species to any well-trained worker so clearly as to obviate confusion with other species. If a so-called species does not fit this requirement, it is not worthy of the rank of species.

Several varieties have been presented in this paper without definite varietal names. This procedure has been followed, because of doubt as to whether these forms should be separated from their respective typical species.

The stratigraphic distribution of the forms here described is shown graphically in figure 3. The columnar section is a compilation made by the Bureau of Economic Geology and taken from the county maps issued by this organization with the Coöperative Mapping Committee in Texas.

Cotypes of new species have been deposited in the collections of the Bureau of Economic Geology, Austin, Texas. All thin sections figured and many of the specimens in the ontogenetic series have also been included in this collection. The rest remain in the collections of the Gypsy Oil Company.

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[12] Plummer, F. B., and Moore, R. C., The stratigraphy of the Pennsylvanian formations of north-central Texas: Univ. Texas Bull. 2132, p. 138, 1921.

[13] Cushman, J. A., and Waters, J. A., Foraminifera of the Cisco group of Texas: Univ. Texas Bull. 3019, 1930. (Sta. C-1, p. 23.)

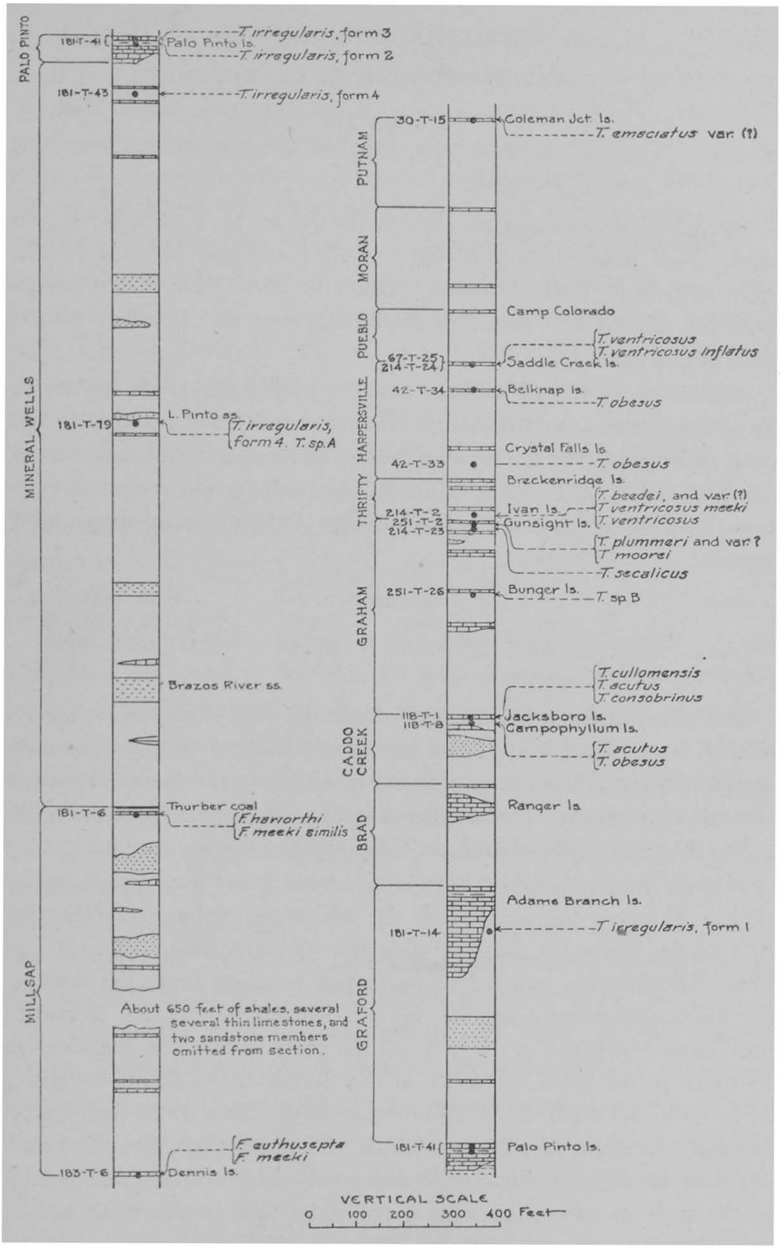

Fig. 3.—Columnar section of the Pennsylvanian strata in north-central Texas showing the distribution of the species described in this paper.

FUSULINA Fischer, 1837

FUSULINA EUTHUSEPTA (Henbest)

Pl. I, figs. 1–3

Fusulinella euthusepta Henbest, 1928, Jour. Pal. vol. 2, p. 80, pl. 8, figs. 6–8; pl. 9, figs. 1, 2, 5. (Illinois.)

Material collected.—Specimens collected by M. E. Upson from a shaly seam near the top of the Dennis limestone, Millsap formation, at Dennis, Parker County, (Sta. 183–T–6) have been contributed for this study. *Fusulina meeki* (Dunbar and Condra) occurs also in this same layer.

Exterior.—Test is of medium size for the genus; adult specimens are from 1.2 mm. to 1.6 mm. in diameter and from 4.3 mm. to 6.2 mm. in length. The form ratio for the adult specimens varies from 1:3.3 to 1:4.2, and averages 1:3.7. An ontogenetic series of over twenty specimens shows little change of form ratio throughout growth:

STAGE	DIAMETER *mm.*	LENGTH *mm.*	FORM RATIO Variation	FORM RATIO Average
Young	.5–1.3	1.7–4.2	1:3.3–1:4.5	1:3.7
Adult	1.2–1.6	4.3–6.2	1:3.3–1:4.2	1:3.7

The shape of the test is elongate-fusiform with straight or slightly curved axis, sharply pointed ends, and lateral slopes that are straight, slightly convex, or concave in different specimens or within the same specimen. The antetheca is of even height from the middle to the ends of the chambers. The septal furrows are flush.

Median section.—Adult individuals have from nine to ten volutions. The average heights of the successive volutions from the first to the tenth are .02, .03, .04, .05, .06, .07, .085, .10, .12, .14 mm. The average number of septa per volution from the first to the ninth respectively are 12, 14, 17, 19, 21, 23, 25, 26, 27, with individual variations of 11 to 13 in the first, 13 to 16 in the second, 15 to 19 in the third, 17 to 22 in the fourth, 20 to 23 in the fifth, 21 to 25 in the sixth, 25 to 26 in the seventh, 25 to 27 in the eighth, and but one count of 27 in the ninth. The proloculum varies from .06 mm. to .08 mm. in outside diameter. The average thicknesses of the wall in successive whorls from the first to the tenth whorl are .005, .005, .01, .01, .02, .02, .025, .03, .035 mm. The height of the chamber cavity is about four times the thickness of the wall in the last whorls. The wall is composed of a diaphanotheca, a thin outer and an inner tectorium, and a tectum. As in all Fusulinae, the wall fibers penetrate all these layers and offer further proof of the porous shell of all fusulinids. In *Fusulina* and *Schubertella* these fibers can be detected only in very thin sections of well-preserved specimens. In this species there are, with practically no variation, ten fibers in .070 mm., as measured in the last whorls.

As in all fusulinids examined, the septa are formed by the bending down of the wall. The septa of fusuline tests appear identical with those of *Triticites*—that is, as if formed by the inbending of the tectum, which is filled by a clear, granular deposit soon after it has ceased to be the antetheca. Well-preserved antetheca appear to be transversely fibrous like the wall and is a portion of the wall bent down to the preceding whorl. This leads to the belief that the clear, granular deposit making the filling in the septa is merely the result of loss of structure which occurs after it has ceased to be the antetheca.

Axial section.—The fluting is obsolescent in the middle of the chambers and weak at the ends. The chomata are strong throughout up to the last stage, in which they may be weak. A secondary deposit increases in thickness from the chomata to the ends of the test, appearing as two solid cones pointing toward the proloculum. In occasional weathered specimens the tunnel is visible from the outside. The average tunnel angles from the first to the ninth whorl successively are 12°, 13°, 15°, 20°, 20°, 20°, 22°, 26°, 30°, with individual variations of 12° to 12.5° in the first, 12.5° to 14° in the second, 12.5° to 20° in the third, 16.5° to 27.5° in the fourth, 16° to 24.5° in the fifth, 16° to 25.5° in the sixth, 19° to 24.5° in the seventh, 22° to 31° in the eighth, and 26.5° to 36.5° in the ninth. No septal pores were noted in the sections made.

Comparison.—Due to the thickening of secondary deposit this species is not likely to be confused with any other except *Fusulina minuta* (Henbest), which is much smaller, more blunt, and has but five or six volutions.

Figured specimens.—Bureau of Economic Geology Coll. Nos. 11741–11743 from Sta. 183–T–6.

FUSULINA HAWORTHI (Beede)

Pl. I, figs. 4–6

Girtyina haworthi Beede, 1916, Ind. Univ. Studies, vol. 3, No. 29, p. 14. (Kansas.)
Fusulinella haworthi Dunbar and Condra, 1927, Nebr. Geol. Survey Bull. 2, ser. 2, p. 82, pl. 2, figs. 6–11. (Illinois, Kansas, well in Nebraska.)

Material collected.—This form is found in abundance in the Gordon limestone near the top of the Millsap formation about three and one-half miles by road west of Millsap on the Gordon road near the eastern edge of Palo Pinto County (Sta. 181–T–6). In the same bed occurs *Fusulina meeki* (Dunbar and Condra) var. *similis* (Galloway and M. P. White) n. var. (ms.)

Exterior.—Test is small to medium size for the genus; specimens are small for the species. Adult specimens vary from 1.3 mm. to 2.0 mm. in diameter and from 3.0 mm. to 4.6 mm. in length. The form ratio for the adult specimens varies from 1:2.0 to 1:2.7 and averages 1:2.4. An ontogenetic series of thirty-four specimens shows an increase in form ratio with growth:

STAGE	DIAMETER *mm.*	LENGTH *mm.*	FORM RATIO Variation	Average
Young	.7–1.3	1.5–2.7	1:1.9–1:2.3	1:2.1
Adult	1.3–2.0	3.0–4.6	1:2.0–1:2.7	1:2.4

The shape of the test is fusiform with straight axis, bluntly pointed ends, and slightly convex lateral slopes. The antetheca is slightly higher at the ends of the chambers than in the middle. Septal furrows are flush to shallow.

Median section.—Adult individuals have from six and one-half to seven and one-half volutions. The average heights of the successive volutions from the first to the last volution are .03, .045, .075, .115, .17, .20, .23, .30 mm. The average number of septa per volution from the first to the seventh whorl respectively are 10, 12, 15, 19, 24, 25, 30, with individual variations of from 8 to 11 in the first, 11 to 13 in the second, 12 to 17 in the third, 16 to 22 in the fourth, 23 to 24 in the fifth, and a single count in the sixth and seventh of 25 and 30. The proloculum is small, even for the species, and averages from .080 mm. to .090 mm. in outside diameter. The average thicknesses of the wall in successive whorls from the first to the seventh whorl respectively are .01, .015, .02,

.03, .035, .035, .04. The height of the chamber cavity is about six times the thickness of the wall in the last whorls. The wall is composed of an outer tectorium, tectum, diaphanotheca, and inner tectorium. With the exception of the tectum, which has practically no thickness, the other three are approximately equal in thickness, though considerable variation in thickness is shown by both the inner and outer tectorium. The fibers are best seen in the diaphanotheca, though they penetrate the tectum and tectoria as well. The fibers are spaced ten in .075 mm. to .090 mm., averaging ten in .085 mm., as measured in the last whorls.

The septa are like those of other species of the genus.

Axial section.—The fluting is moderate to strong in the middle of the chambers and strong in the ends. The chomata are strong throughout. The average tunnel angles from the first to the sixth whorl successively are 20°, 24°, 25°, 32°, 35°, and 25°, with an individual variation of 11° to 28° in the first, 17° to 30° in the second, 18° to 30.5° in the third, 25° to 44° in the fourth, 29.5° to 43.5° in the fifth, with a single reading of 25° in the sixth. A few small septal pores were observed.

Comparison.—This species is larger and more fluted than *F. inconspicua* Girty. The form here described has a smaller proloculum than the type from Kansas. In the Ardmore Basin, the size of the proloculum has been found to change consistently upward. The size of the proloculum has therefore proved to be a very helpful feature in subdividing the species for identification of the age of the strata.

Figured specimens.—Bureau of Economic Geology Coll. Nos. 11744–11746 from Sta. 181–T–6.

FUSULINA MEEKI (Dunbar and Condra)

Pl. I, figs. 7–12

Fusulinella meeki Dunbar and Condra, 1927, Nebr. Geol. Survey Bull. 2, ser. 2, p. 78, pl. 2, figs. 12–14; pl. 15, figs. 4–6. (Missouri, Texas.)

Material collected.—A large number of specimens collected by M. E. Upson from a shaly seam in the upper part of the Dennis limestone, Millsap formation, at Dennis, Parker County, (Sta. 183–T–6) have been contributed for this study. In the same bed *Fusulina euthusepta* (Henbest) occurs commonly.

Exterior.—Specimens from the one sample available have been divided into two groups based mainly on shape. It will be noted that the range in the form ratio of one group begins where the other leaves off. It is quite likely that both groups should be combined and described together, as suggested by Dunbar and Condra. As the material has, however, been studied in two separate groups, the characteristics of this species will be presented separately for these groups, both of which are included in the species.

The tests of one group are somewhat more than medium size for the genus; those of the other of medium size. Adult specimens of the first group vary from 1.9 mm. to 2.2 mm. in diameter and from 4.7 mm. to 5.7 mm. in length, a gerontic stage being recognized in this group and not in the second. Adult specimens of the second group vary from 2.1 mm. to 3.1 mm. in diameter and from 3.6 mm. to 5.7 mm. in length. The form ratio of adults of the first group varies from 1:2.3 to 1:2.9 and averages 1:2.5. The form ratio of adults of the second group varies from 1:1.6 to 1:1.9 and averages 1:1.7. An ontogenetic series of thirty-two specimens from the first group and a series of twenty-five from the second group have been measured:

STAGE	DIAMETER	LENGTH	FORM RATIO	
	mm.	*mm.*	Variation	Average
First group—				
Young	1.0–1.7	2.0–4.1	1:1.8–1:2.8	1:2.2
Adult	1.9–2.2	4.7–5.7	1:2.3–1:2.9	1:2.5
Gerontic	2.1–2.6	6.1–6.7		1:2.8
Second group—				
Young	1.0–2.4	1.5–3.2	1:1.2–1:1.7	1:1.4
Adult	2.1–3.1	3.6–5.7	1:1.6–1:1.9	1:1.7

The shape of specimens of the first group is fusiform to rhomboidal with straight axis, straight to convex lateral slopes even within the same individual, and broadly rounded to bluntly pointed ends. The specimens of the second group are inflated with straight axis, convex lateral slopes, and obtusely to broadly pointed ends. In specimens of both groups the antetheca is of even height to the ends, where it becomes slightly higher. In both groups septal furrows are flush to shallow.

Median section.—There are from six to seven and one-half volutions in adult specimens of the first group, from seven to eight and one-half in adults of the second group. The average heights of the successive volutions from the first to the seventh whorl of specimens of the first group are .06, .07, .12, .16, .21, .25, .23 mm. The same measurements of specimens of the second group are .07, .10, .13, .16, .21, .24, .28, .32 mm. The average number of septa per volution from the first to the fifth whorl of specimens of the first group are 12, 18, 20, 21, 28, respectively, with individual variations of 11 to 12 in the first, 15 to 20 in the second, 19 to 20 in the third, 18 to 23 in the fourth, and 27 to 28 in the fifth. The number of septa per volution from the first to the seventh whorl of specimens of the second group are 11, 20, 24, 31, 36, 40, 43, with individual variations of 10 to 12 in the first, 19 to 20 in the second, 23 to 26 in the third, 30 to 33 in the fourth, 34 to 38 in the fifth, 36 to 43 in the sixth, and 42 to 44 in the seventh. The outside diameter of the proloculum of specimens of the first group varies from .165 mm. to .240 mm.; for the second group from .155 mm. to .220 mm. The average thicknesses of the wall in successive whorls from the first to the seventh whorl of specimens of the first group are .02, .03, .035, .04, .05, .05, .06 mm. From the first to the eighth whorl of specimens of the second group the wall thicknesses are .02, .03, .04, .04, .05, .05, .055, .055 mm. In the last whorls of specimens of the first group the height of the chamber cavity is from four to five times the thickness of the wall. In the later whorls of specimens of the second group the height is approximately five times the thickness of the wall. The wall is composed of an outer and an inner tectorium, tectum, and diaphanotheca. The tectum of the tests is very thin. The outer and inner tectoria vary greatly but are approximately equal in thickness and very little thinner than the diaphanotheca. The fibers are best observed in the diaphanotheca, though they extend through all layers. In specimens of both groups the fibers are spaced ten in .060 to .070 mm. and average ten in .065 mm., as measured in the last whorls.

The septa are normal for the genus, as described under *Fusulina euthusepta* (Henbest).

Axial section.—In the middle of the chambers the fluting is moderate to strong in specimens of the first group, and strong in those of the second. It is strong to intense in both groups in the ends of the chambers. The chomata are strong throughout specimens of both groups, so that the tunnel can be seen on the outside of many partially weathered specimens. The average tunnel angles from the first to the sixth whorl of specimens of the first group are successively 15°, 18°, 20°, 24°, 32°, 39°, with individual variations of 11.5° to 17° in the first, 13° to 22° in the second, 17° to 21.5° in the third, 21.5° to 25.5° in the fourth, 20° to 37° in the fifth, and 35° to 45° in the sixth. Measurements from the first to the seventh whorls of specimens of the second group average 14.5°, 16°, 18°, 17.5°, 20.5°, 23°, 25.5°, with an individual variation of 12.5° to 16° in the first, 13° to 17.5° in the second, 16.5° to 20° in the third, 15° to 20.5° in the fourth, 17° to 25° in the fifth, 22° to 24.5° in the sixth, and 21° to 32° in the seventh. A few septal pores measuring as much as .015 mm. in diameter were observed in specimens of both groups.

Comparisons.—Except for the difference in shape expressed also by difference of form ratio, the difference in septal count, always of questionable value, and a slight variation in fluting and tunnel angle, the two groups of this species are very similar. Dunbar and Condra note the occurrence of both groups in this shale bed, their figure 14 of Plate 2 and figure 6 of Plate 15 representing the second group. There is little danger of confusion of these forms with any others described in this paper, barring the variety *similis* Galloway and M. P. White n. var. (ms.) under the description of which comparison is made. The great thickness of wall and large size of the proloculum in these two forms of the species differentiate them from other species.

Figured specimens.—Bureau of Economic Geology Coll. Nos. 11747–11749 (first group) and Nos. 11750–11752 (second group), all from Sta. 183–T–6.

FUSULINA MEEKI (Dunbar and Condra) var. SIMILIS (Galloway and M. P. White), n. var. (ms.)

Pl. I, figs. 13–15

Fusulinella meeki similis Galloway and White, manuscript on the fusulinids of the Ardmore Basin, now in process of completion.

Material collected.—This species occurs in abundance in the Gordon limestone near the top of the Millsap formation about three and one-half miles by road west of Millsap on the road to Gordon, near the eastern edge of Palo Pinto County (Sta. 181–T–6). In the same bed occurs *Fusulina haworthi* (Beede).

Exterior.—Only the young and adult stages are recognized in specimens of this variety of the species. Test is small for both the species and variety. Adult specimens vary from 1.5 mm. to 2.0 mm. in diameter and from 2.7 mm. to 3.6 mm. in length. The form ratio varies from 1:1.5 to 1:2.0 and averages 1:1.8. An ontogenetic series of thirty-three specimens shows an increase in form ratio with growth:

STAGE	DIAMETER *mm.*	LENGTH *mm.*	FORM RATIO Variation	Average
Young	.8–1.7	1.3–2.5	1:1.4–1:1.7	1:1.6
Adult	1.5–2.0	2.7–3.6	1:1.5–1:2.0	1:1.8

The test is inflated and has a straight axis, obtusely to broadly pointed ends, and convex lateral slopes. The antetheca is of even height from the middle to the ends of the chambers. The septal furrows are flush to very shallow.

Median section.—Adult specimens have from five and one-half to seven volutions. The average heights of the successive volutions from the first to the seventh whorl are .04, .06, .085, .15, .18, .22, .23 mm. The average number of septa per volution from the first to the sixth whorl respectively are 9, 12, 17, 19, 25, 29, with individual variations of 18 to 20 in the fourth, and 21 to 28 in the fifth, only one reading being obtained for the sixth, and no variation shown in the specimens sectioned for the first, second, and third. The proloculum is very small for the species, the outside diameter measuring from .080 mm. to .095 mm. The average thicknesses of the wall in successive whorls from the first to the seventh whorl are .015, .02, .03, .04, .045, .05, .05 mm. The height of the chamber cavity is somewhat over four times the thickness of the wall, as measured in the last whorls. The wall is composed of outer and inner tectoria, tectum, and diaphanotheca. Though the inner and outer tectoria vary considerably in thickness while the diaphanotheca does not, all layers are approximately equal in thickness. The tectum has practically no thickness. Fibers are best seen in the diaphanotheca, but they extend through all the other portions of the wall. In the outer whorls ten fibers occupy a space of .080 mm. to .085 mm. and average ten in .080 mm. The septa are normal for the genus, a description of which is included under *Fusulina euthusepta* (Henbest).

Axial section.—The fluting and chomata are strong throughout each specimen, but no tunnel is evident from the outside of specimens examined, due probably to good preservation. The average tunnel angles from the first to the sixth whorl successively are 16.5°, 20°, 20.5°, 19°, 22°, 24°, with an individual variation of 14° to 21° in the first, 16° to 23° in the second, 18° to 22° in the third, 18° to 19° in the fourth, 21° to 23° in the fifth, and 20° to 26.5° in the sixth. A few septal pores measuring as much as .015 mm. in diameter were observed in one of the sections.

Comparison.—The variety differs from the typical species in shape and therefore in form ratio, being more gibbous, especially if the two groups of the species described in this paper are combined. The proloculum of the variety is small, whereas that of the species is large. The fibers of the species are much finer than those of the variety, ten in .065 mm. as compared to ten in .080 mm. or more.

Figured specimens.—Bureau of Economic Geology Coll. Nos. 11753–11755 from Sta. 181–T–6. Cotypes of this manuscript species will be described later from the Ardmore Basin, Oklahoma.

TRITICITES Girty, 1904

TRITICITES ACUTUS Dunbar and Condra

Pl. II, figs. 1–6

Triticites acutus Dunbar and Condra, 1927, Nebr. Geol. Survey Bull. 2, ser. 2, p. 113, pl. 9, figs. 5–8. (Iowa, Nebraska.)

Material collected.—Two samples containing this species were collected from two layers stratigraphically about 20 feet apart:

1. Shale about 10 feet above the *Campophyllum* limestone, Caddo Creek formation, in an exposure on the Rock Island Railroad under the viaduct 3.7 miles by road southeast of the courthouse at Jacksboro, Jack County (Sta. 118–T–8). This species is very abundant in the top of this bank. *Triticites obesus* (Beede) occurs in abundance in the same bed.
2. Jacksboro limestone, Caddo Creek formation, in an exposure on the Gulf Texas and Western Railroad under the viaduct 3.4 miles by road southeast of the courthouse at Jacksboro, Jack County (Sta. 118–T–1). This species occurs in abundance with *Triticites cullomensis* Dunbar and Condra and *T. consobrinus* Galloway and Ryniker. n.sp. (ms.). The Jacksboro limestone

ledge lies about 30 feet above the *Campophyllum* limestone in the outcrop described above.

Exterior.—Test is of medium size for the genus; adult forms are from 1.4 mm. to 2.6 mm. in diameter and from 4.5 mm. to 7.8 mm. in length. The form ratio for the adult specimens varies from 1:2.7 to 1:3.7 and averages 1:3.2. An ontogenetic series of twenty-five specimens from each of two samples shows an increase of form ratio with growth:

STAGE	DIAMETER mm.	LENGTH mm.	FORM RATIO Variation	FORM RATIO Average
First sample—				
Young	.6–1.2	1.3–3.1	1:2.1–1:2.8	1:2.4
Adult	1.6–2.4	4.5–7.7	1:2.8–1:3.7	1:3.2
Gerontic	2.0–2.8	8.2–9.5	1:3.2–1:4.1	1:3.6
Second sample—				
Young	1.0–1.1	2.2–3.6	1:2.3–1:2.7	1:2.6
Adult	1.4–2.6	4.9–7.8	1:2.7–1:3.6	1:3.1
Gerontic	2.1–2.7	8.2–9.4	1:3.1–1:3.8	1:3.5

Only one specimen has a form ratio greater than 1:3.8, a gerontic specimen of the first sample with a ratio of 1:4.1, as shown in the table.

The shape of the test is elongate-fusoid to elliptical with broadly rounded to bluntly pointed ends, straight axis and gently convex lateral slopes. The antetheca increases in height from the middle to the ends. The septal furrows are shallow to deep.

Median section.—Adult specimens from both the first and second samples show from seven to seven and one-half, and from seven to eight whorls, respectively. The heights of the successive volutions from the first to the last whorl of the specimens of the first sample are .04, .055, .095, .135, .19, .28, .325 mm.; for the second sample, .035, .05, .08, .13, .19, .26, .29, .30 mm. The average number of chambers per whorl from the first to the last whorl in tests of the first sample is, 11, 16, 19, 22, 23, 26, 27; in those of the second, 12, 17, 17, 19, 22, 25, 28, 29. Individual variations for tests of the first sample where variation was noted, are 10 to 12 in the first whorl, 15 to 16 second, 18 to 20 third, 21 to 23 fourth, 25 to 27 sixth, 26 to 27 seventh; in the second sample, 21 to 23 in the fifth and 23 to 26 in the sixth. The proloculum of specimens of the first sample varies from .095 to .140 mm. in diameter; in the second from .085 to .145 mm. The average thicknesses of the wall in successive whorls from the first to the last whorl in specimens of the first sample are .015,

.02, .03, .04, .06, .085, .11, .12 mm.; of the second .015, .02, .025, .04, .06, .08, .09, .09 mm. The height of the chamber cavity in the last whorls is about three times the thickness of the wall. The wall is composed of a thin tectum and a conspicuously alveolar keriotheca, which in the specimens of the first sample has ten alveoli in .130 to .170 mm. and averages .150 mm.; in those of the second, ten occupy from .120 to .140 mm. and average ten in .130 mm., as measured in the last whorls.

The septa are normal for the genus.

Axial section.—The fluting is moderate to strong in the middle of the chambers and strong at the ends. The chomata are strong practically throughout except in the last part of some tests. The tunnel can be seen from the outside of some specimens due to the collapse of the wall between the chomata. The average tunnel angles from the first to the last whorl in specimens of the first sample are successively 19°, 25°, 29.5°, 38°, 47°, 46°; in the specimens of the second, 16.5°, 22°, 33°, 37.5°, 45°, 49°, 44°. The individual variations are 18° to 21°, 21° to 34°, 24.5° to 35°, 32.5° to 46°, 42° to 56°, 37° to 54.5° and 9.5° to 25°, 17° to 26°, 25° to 45°, 28° to 43°, 37° to 55°, 42° to 57°. Septal pores are fairly numerous and small.

Comparisons.—This species is much like *Triticites cullomensis* Dunbar and Condra and *T. secalicus* (Say). It is compared with *T. cullomensis* under that species. *T. secalicus* is larger, more elliptical in shape, has a larger and more uniformly sized proloculum, shows less fluting and a larger tunnel angle, and its wall is characterized by finer alveolar structure.

Figured specimens. — Bureau of Economic Geology Coll. Nos. 11759–11761 (first sample) from Sta. 181–T–8, and Nos. 11762–11764 (second sample) from Sta. 181–T–1.

TRITICITES BEEDEI Dunbar and Condra

Pl. I, figs. 16–18

Triticites beedei Dunbar and Condra, 1927, Nebr. Geol. Survey Bull. 2, ser. 2, p. 96, pl. 5, figs. 1, 2; pl. 6, figs. 7–10. (Nebraska, Missouri, Iowa, Kansas.)

Material collected.—This species is abundant about 75 feet above the upper Gunsight limestone and about 20 feet below the Ivan limestone, Thrifty formation, in the second prominent escarpment along the Ivan-Breckenridge highway about two and one-half miles southwest of Ivan, Stephens County (Sta. 214–T–2). With this form *T. ventricosus* (Meek) and *T. ventricosus* var. *meeki* (Möller) occur also in abundance.

Exterior.—Test is of medium size for the genus; adult forms range from 2.8 mm. to 3.7 mm. in diameter and from 5.1 mm. to 7.8 mm. in length. The form ratio for the adult specimens varies from 1:1.8 to 1:2.2 and averages 1:1.9. Though division of suites of specimens into young, adult, and gerontic is more or less arbitrary, no gerontic stage is here recognized because, contrary to the usual assemblage there were not the few specimens notably larger than the average large specimen. An ontogenetic series of seventeen specimens shows an increase of form ratio with growth:

STAGE	DIAMETER *mm.*	LENGTH *mm.*	FORM RATIO Variation	FORM RATIO Average
Young	.8–2.4	1.3–3.9	1:1.5–1:1.8	1:1.7
Adult	2.8–3.7	5.1–7.8	1:1.8–1:2.2	1:1.9

The shape of the test is thickly inflated to somewhat diamond shaped, with bluntly pointed to broadly rounded ends and a straight axis; its lateral slopes vary from gently convex through straight to concave. The antetheca is of uniform height from middle to ends. The septal furrows are shallow.

Median section.—Adult specimens have from six to seven and one-half whorls. The average heights of successive volutions from the first to the last whorl are .05, .08, .15, .22, .30, .34, .37, .22 mm. The average number of chambers per whorl from the first to the seventh whorl respectively are 14, 18, 22, 25, 28, 33, 35 with individual variations of 20 to 23 in the third, 24 to 25 in the fourth, 27 to 29 in the fifth, 32 to 33 in the sixth, as seen in thin sections. The proloculum varies from .14 mm. to .20 mm. in diameter. The average thicknesses of the wall in successive whorls from the innermost to the outer whorl are .02, .03, .04, .05, .08, .09, .09, .08 mm. The height of the chamber cavity in the later whorls is about four times the thickness of the wall. The wall is composed of a thin tectum and a conspicuously alveolar keriotheca, which has ten alveoli in .160 mm. to .190 mm. and averages ten in .170 mm., as measured in the later whorls.

The septa are like those in other species of the genus. Due to the strong chomata they are likely to show thickening and to coalesce at the ends.

Axial section.—The fluting is moderate in the middle of the chambers and strong at the ends. The chomata are strong except in the last chambers where they may be weak. The tunnel is not visible from the outside of specimens. The average tunnel angles from the first to the sixth volution successively are 15.5°, 15°, 19°, 25°, 28°, 28°, with an individual variation of 14° to 19° in the first, 14.5° to 17° in the second, 15° to 24° in the third, 16.5° to 30.5° in the fourth, 24.5° to 36° in the fifth, and 29° to 30° in the sixth. Septal pores are few and very small for the genus.

Comparisons.—Dunbar and Condra state the number of volutions to be rather high, eight and one-half to more than nine, though their figured specimens show from seven to eight. The thickness of the wall in the early whorls, as given by the above authors, is considerably greater than the thickness here recorded. The specimens studied for this paper show in the early whorls great thickening by the chomata which, if included, would increase the wall thickness for these specimens. This species is separated from the variety of *Triticites plummeri* Dunbar and Condra, described in this paper, by its much larger proloculum and by the greater height of its volutions. This form is compared with *Triticites consobrinus* Galloway and Ryniker n.sp. (ms.) under that species.

Figured specimens.—Bureau of Economic Geology Coll. Nos. 11756–11758 from Sta. 214–T–2.

TRITICITES BEEDEI Dunbar and Condra var.?

Pl. II, figs. 7–9

Material collected.—This possible variety occurs rather rarely in the shale about five feet above the upper Gunsight limestone and about 90 feet below the Ivan limestone, Thrifty formation, in the second prominent escarpment along the Ivan-Breckenridge highway about two and one-half miles southwest of Ivan, Stephens County (Sta. 214–T–2). In this same bed *Triticites ventricosus* (Meek) occurs in abundance.

Exterior.—The test is small for the genus in a fauna that is probably dwarfed. No gerontic stage is recognized in the specimens collected. Adult forms vary from 2.0 mm. to 3.1 mm. in diameter and from 3.3 mm. to 5.3 mm. in length. The form ratio for the adult specimens varies from 1:1.4 to 1:1.9 and averages 1:1.6. An ontogenetic series of fourteen specimens shows a slight but steady increase of form ratio with growth:

STAGE	DIAMETER	LENGTH	FORM RATIO	
	mm.	*mm.*	Variation	Average
Young	.5–1.7	.8–2.7	1:1.3–1:1.6	1:1.5
Adult	2.0–3.1	3.3–5.3	1:1.4–1:1.9	1:1.6

The shape of the test is inflated with broadly rounded ends, straight axis, and convex lateral slopes. The antetheca is of uniform height from middle to ends. The septal furrows are flush to shallow.

Median section.—Adult tests are composed of six and one-half to seven and one-half volutions. The average heights of the successive volutions from the first to the last whorl are .045, .07, .10, .16, .21, .28, .30 mm. The average number of septa per volution from the first to the seventh whorl respectively are 14, 17, 21, 25, 28, 32, 28, with individual variations of from 13 to 14 in the first, 15 to 19 in the second, 19 to 23 in the third, 24 to 26 in the fourth, 27 to 29 in the fifth, 26 to 38 in the sixth, and but one count of 28 for the seventh. The proloculum varies from .100 mm. to .180 mm. in diameter, all but one being .150 mm. or greater. The average thicknesses of the wall from the first to the seventh whorl respectively are .015, .02, .03, .04, .055, .08, .09 mm. The height of the chamber cavity in the later whorls is about three and one-half times the thickness of the wall. The wall is composed of a thin tectum and a conspicuously alveolar keriotheca, which has ten alveoli in .140 mm. to .180 mm. and averages ten in .150 mm., as measured in the last whorls.

The septa are like those of other species and inclined to be thickened and apparently to coalesce because of the deposition from the chomata.

Axial section.—The fluting is moderate, or possibly even moderate to strong in the middle of the chambers, and strong at the ends. The chomata are massive, or at least strong, throughout. The tunnel is not visible from the outside of the specimens. The average tunnel angles from the first to the sixth whorl successively are 16°, 16°, 16°, 20°, 20°, 23.5°, with an individual variation of from 13.5° to 20° in the first, 14° to 19° in the second, 14° to 18° in the third, 17.5° to 22° in the fourth, 17° to 24° in the fifth, and

16° to 27° in the sixth. Septal pores were few and measure as much as .015 mm. diameter.

Comparisons.—This variety of the species differs from the typical form described by Dunbar and Condra in the same manner as does the typical species described in this paper but to an even greater degree, probably in part at least for the same reasons given under the species, and yet not to so great a degree as in a form tentatively placed under the genus by Galloway and Ryniker in a manuscript form from the top of the South Bend shale. The variety differs from the typical species, as described in this paper, in its somewhat more gibbous shape expressed by a lower form ratio, in its slightly lower height of volutions, its wall thickness, and its finer alveolar structure. Its possible confusion with other forms may be compared by considering it as the species and noting the contrasts drawn under the species. There is some doubt as to the advisability of making a variety of this form but unquestionably many workers are inclined to regard as a variety the form here described as the typical species.

Figured specimens.—Bureau of Economic Geology Coll. Nos. 11765–11767 from Sta. 214–T–2.

TRITICITES COMPACTUS M. P. White, n.sp.

Pl. II, figs. 10–12

Material collected.—At Gap Tank, Glass Mountains, Pecos County (Sta. 185–T–3), specimens of this species were collected by Fielding Bohart from the upper Gaptank formation and contributed for this study.

Exterior.—As only six specimens were available for examination, and all apparently adult forms, it has been impossible to attempt to subdivide this small group into stages. The specimens vary from 3.0 mm. to 3.7 mm. in diameter and from 9.3 mm. to 10.0 mm. in length. The form ratio varies from 1:2.4 to 1:3.3 and averages 1:2.8.

The shape of the test is fusoid with bluntly pointed ends, straight axis, and gently convex lateral slopes. The antetheca is of uniform height from the middle of the chambers to the ends. The septal furrows are shallow.

Median section.—Thin sections of adult specimens show from seven to eight volutions. The average heights of the successive volutions from the first to the eighth whorl are .07, .09, .14, .24, .31, .32,

.35, .40 mm. A septal count was obtained in only one test; the number of septa per volution from the first to the sixth volution respectively are 10, 20, 20, 25, 39, 39. The proloculum varies from .140 mm. to .160 mm. in outside diameter. The average thicknesses of the wall from the first to the seventh whorl respectively are .015, .03, .035, .055, .08, .09, .09 mm. The height of the chamber cavity in the later whorls is almost four times the thickness of the wall. The wall is composed of a thin tectum and a conspicuously alveolar keriotheca, which has ten alveoli in .150 mm. to .200 mm. and averages ten in .180 mm., as measured in the last whorls.

The septa are like those of other species of the genus.

Axial section.—Fluting is strong through the middle and intense in the ends of the chambers. Chomata are developed only in the first two whorls. The average tunnel angles for the first and second whorls respectively are 28° to 31°, with individual variations of 25° to 31° in the first whorl and 22° to 39° in the second. The unsusual and chief distinguishing character of the species is the filling of secondary deposit which expands as a cone from the proloculum to both ends of the test. This character in the lower fusulinellids gives rise to the designation of a separate genus, *Wedekindella.* The early discussion in this paper gives the reasons for not recognizing this genus. A few septal pores are present in the last whorl.

Comparison. — No other form should be confused with this species, for the filling of secondary deposit alone is sufficient to distinguish it from all others. A comparison with the variety of the species is left to the description of the variety.

Cotypes.—Bureau of Economic Geology Coll. Nos. 11768–11770 from Sta. 185–T–3.

TRITICITES COMPACTUS M. P. White, n. sp., var.?

Pl. II, figs. 13–15

Material collected.—Specimens of this varietal form of the species were collected from an ant-hill in the upper Gaptank formation at Gap Tank, Glass Mountains, Pecos County, (Sta. 185–T–3) by Fielding Bohart.

Exterior.—This variety of the species is based on only six entire specimens and about as many sectioned specimens. Probably all the specimens can safely be classed as adult. They range from 2.4

mm. to 2.8 mm. in diameter and from 4.4 mm. to 6.2 mm. in length. The form ratio varies from 1:1.8 to 1:2.2 and averages 1:2.1.

The shape of the test is inflated and axial sections present a roughly hexagonal outline in which two of the sides, those not forming the lateral slopes, are parallel and of unequal length. The ends are rather broadly rounded, axis straight with convex or straight lateral slopes. The antetheca is of uniform height from the middle to the ends of the chambers. The septal furrows are shallow.

Median section.—The thin sections show from six to eight volutions. The average heights of the successive volutions from the first to the seventh whorl are .07, .08, .12, .18, .255, .245, .295 mm. One septal count from the first to the fifth whorl gives 11, 23, 31, 34, 39 chambers respectively. The proloculum varies from .120 mm. to .200 mm. in outside diameter. The average thicknesses of the wall in successive whorls from the first to the seventh whorl are .015, .025, .035, .05, .06, .055, .07 mm. The height of the chamber cavity in the later whorls is about four times the thickness of the wall. The wall is composed of a thin tectum and conspicuously alveolar keriotheca, which has ten alveoli in .170 mm. to .200 mm. and averages ten in .180 mm., as measured in the last whorls.

The septa are like those of other species of the genus.

Axial section.—Fluting is intense throughout the chambers. No chomata were noted in the thin sections. The chief distinguishing character of the typical species, the filling of secondary deposit which expands as a cone from the proloculum to both ends of the test, is present also in the variety. Septal pores are lacking.

Comparisons.—The variety differs from the typical species in its more gibbous shape and accompanying lower form ratio. The lower height of its volutions, its thinner walls, higher septal count, greater fluting, and lack of chomata further differentiate the variety from the species. Despite these differences the two forms are very similar and closely related.

Figured specimens.—Bureau of Economic Geology Coll. Nos. 11771–11773 from Sta. 185–T–3.

TRITICITES CONSOBRINUS Galloway and Ryniker, n.sp. (ms.)

Pl. II, figs. 16–18

Triticites consobrinus Galloway and Ryniker, manuscript on "Characters of Northern Mid-Continent Fusulinidae," and "Characters of Fusulinidae of the Mid-Continent Region."

Material collected.—This species occurs in abundance in the Jacksboro limestone in an exposure on the Gulf Texas and Western Railroad under the viaduct 3.4 miles by road southeast of the Jacksboro courthouse, Jack County, on the highway to Mineral Wells (Sta. 118–T–1). Accompanying abundant forms are *Triticites acutus* Dunbar and Condra and *T. cullomensis* Dunbar and Condra.

Exterior.—Test is of medium size for the genus; adult forms range from 1.9 to 3.2 mm. in diameter and from 4.3 to 6.3 mm. in length. The form ratio of adult specimens varies from 1:1.7 to 1:2.3 and averages 1:2.0. An ontogenetic series of twenty-six specimens shows an increase of form ratio with growth:

STAGE	DIAMETER	LENGTH	FORM RATIO	
	mm.	*mm.*	Variation	Average
Young	.4–2.0	1.0–4.0	1:1.4–1:2.2	1:1.8
Adult	1.9–3.2	4.3–6.3	1:1.7–1:2.3	1:2.0
Gerontic	3.5	6.8–7.2	1:2.0–1:2.1	1:2.0

The shape of the test is inflated with broadly pointed ends, straight axis, and convex lateral slopes. The antetheca shows a very slight increase in height from middle toward the ends. The septal furrows are shallow.

Median section.—Sectioned adult specimens show from nine to nine and one-half volutions. The average heights of the successive volutions from the first to the last whorl are .03, .045, .06, .09, .13, .175, .22, .27, .31, .40 mm. In some axial sections it is difficult to distinguish the first chamber from the proloculum. The average number of septa per volution from the first to the eighth whorl respectively are 12, 16, 19, 22, 27, 28, 30, 34, with individual variations of 15 to 17 in the second, 18 to 19 in the third, 21 to 22 in the fourth, 26 to 27 in the fifth, 26 to 30 in the sixth, and 31 to 37 in the eighth. The proloculum is small, from .06 mm. to .10 mm. in outside diameter. The average thicknesses of the wall in successive whorls from the first to the last whorl are .01, .015, .02, .03, .035,

.05, .07, .085, .10 mm. The height of the chamber cavity in the last whorls is about four times the thickness of the wall. The wall is composed of a thin tectum and a conspicuously alveolar keriotheca, which has ten alveoli in .140 mm. to .170 mm. and averages ten in .160 mm., as measured in the later whorls.

The septa are like those in other species of the genus.

Axial section.—The fluting in the middle of the chambers is moderate, possibly even moderate to strong, and strong in the ends. The chomata are strong throughout, though the tunnel is not noticeable from the outside of specimens examined. The average tunnel angles from the first to the ninth whorl successively are 21°, 19°, 19°, 17°, 19°, 23°, 23°, 28°, 21°, with individual variations of from 14° to 28° in the first, 14° to 28° in the second, 15° to 27.5° in the third, 14° to 22.5° in the fourth, 14° to 27° in the fifth, 18° to 30° in the sixth, 20° to 31° in the seventh, 23° to 34° in the eighth, and but one measurement of 21° for the ninth.

Septal pores are either small and obscured by mineralization or are absent.

Comparisons.—This form varies considerably from the one described under this specific name on the "Northern Mid-Continent" chart, but is very similar to a form to be described from the basal Foraker formation, though differing from two others described in the same compilation. This species differs from *Triticites plummeri* Dunbar and Condra var.?, with which it is probably very closely related, in the lower heights of its corresponding volutions, in its thinner walls, its smaller size, and its somewhat different shape. It also resembles *Triticites beedei* Dunbar and Condra to some extent but differs in its smaller proloculum and its lower height of volution. It differs from *Triticites ventricosus* (Meek) var. *inflatus* Galloway and Ryniker n. var. (ms.) in its much smaller proloculum, less height of volution, thinner wall, and smaller tunnel angle.

Figured specimens.—Bureau of Economic Geology Coll. Nos. 11774–11776 from Sta. 118–T–1. Cotypes of this manuscript species will later be figured from the northern part of the Mid-Continent area.

TRITICITES CULLOMENSIS Dunbar and Condra

Pl. III, figs. 1–3

Triticites cullomensis Dunbar and Condra, 1927, Nebr. Geol. Survey Bull. 2, ser. 2, p. 93, pl. 5, figs. 5–10. (Nebraska, Kansas, Missouri, Texas.)

Material collected.—An abundance of tests of this species have been collected from the Jacksboro limestone, Caddo Creek formation, in the railroad cut on the Gulf Texas and Western Railroad under the viaduct 3.4 miles by road southeast of the Jacksboro courthouse, Jack County, on the highway to Mineral Wells (Sta. 118–T–1). In the same ledge *T. acutus* Dunbar and Condra and *T. consobrinus* Galloway and Ryniker n.sp. (ms.) occur.

Exterior.—Test is of medium size for the genus; adult forms are from 1.5 mm. to 2.4 mm. in diameter and from 4.3 mm. to 6.9 mm. in length. The form ratio for the adult specimens varies from 1:2.6 to 1:3.1 and averages 1:2.8. An ontogenetic series of over thirty specimens shows an increase of form ratio with growth:

STAGE	DIAMETER	LENGTH	FORM RATIO	
	mm.	*mm.*	Variation	Average
Young	.5–1.7	.9–3.9	1.1.7–1:2.7	1:2.3
Adult	1.5–2.4	4.3–6.9	1:2.6–1:3.1	1:2.8
Gerontic	2.2–2.7	7.2–7.7	1:2.8–1:3.3	1:3.1

The shape of the test is elliptical with broadly rounded ends, straight axis, and convex lateral slopes. The antetheca increases in height from the middle to the ends. The septal furrows are shallow to deep.

Median section.—Full-grown specimens have from six to seven whorls. The average heights of the successive volutions from the first to the seventh whorls are .055, .07, .11, .17, .22, .28, .30 mm. The average number of chambers per volution from the first to the sixth whorl respectively are 14, 18, 20, 19, 24, 28, with individual variations of 13 to 14 in the first, 18 to 20 in the fourth, 23 to 24 in the fifth, and 26 to 30 in the sixth. The proloculum shows a rather wide range in outside diameter, from .135 mm. to .240 mm. The average thicknesses of the wall in successive whorls from the first to the seventh whorl are .02, .02, .03, .045, .07, .09, .10 mm. The height of the chamber cavity in the later whorls is three times the thickness of the wall. The wall is composed of a thin tectum and a conspicuously alveolar keriotheca, which has ten alveoli in

.140 mm. to .180 mm., as measured in the last whorls, and averages .155 mm.

The septa are like those of other species of the genus and are unimportant.

Axial section.—The fluting is obsolescent in the middle of the chambers and strong at the ends. The chomata are strong practically throughout, except in the last part of some specimens. The tunnel is visible from the outside of some tests, due to a slight collapse of the wall between the chomata. The average tunnel angles from the first to the sixth whorl successively are 20°, 21°, 29°, 37°, 44°, 46°, with individual variations taken in the same order, 14° to 22.5°, 16° to 34°, 20° to 35.5°, 33° to 41.5°, 37° to 70°, 42° to 55.5°. The 70-degree angle observed in the fifth whorl was found in but one side of one specimen. Disregarding this abnormally high angle, the variation is from 37° to 42°, and the average for the fifth whorl 39°, instead of 44°. Septal pores are few and small.

Comparisons.—This species resembles both *T. secalicus* (Say) and *T. acutus* Dunbar and Condra. It is compared with *T. secalicus* under the description of that species. *T. cullomensis* Dunbar and Condra is smaller than *T. acutus*, possesses a lower form ratio, is more elliptical and not so pointed, has less fluting in the middle of the chambers, and has a larger proloculum.

Figure specimens.—Bureau of Economic Geology Coll. Nos. 11777–11779 from Sta. 118–T–1.

TRITICITES EMACIATUS (Beede)

Pl. III, figs. 4–6

Fusulina emaciata Beede, 1916, Ind. Univ. Studies, vol. 3, No. 29, p. 14. (Kansas.)

Fuslina emaciata, Dunbar and Condra, 1927, Nebr. Geol. Survey Bull. 2, ser. 2, p. 116, pl. 10, figs. 1–3. (Kansas, Nebraska.)

Material collected.—Specimens of this species were collected from the upper Gaptank formation at Gap Tank, Glass Mountains, Pecos County, (Sta. 185–T–3) by Fielding Bohart.

Exterior.—The test is of medium size for the genus; specimens examined are 1.7 mm. to 2.5 mm. in diameter and 5.7 mm. to 8.7 mm. in length, giving a form ratio varying from 1:2.9 to 1:3.8

and averaging 1:3.5. As only seven specimens have been available for study, no attempt has been made to divide this small group into stages, and all are assumed to be adult.

The shape of the test is elongate-elliptical with broadly rounded ends, straight axis, and gently convex lateral slopes. The antetheca increases in height from the middle to the ends of the chambers. The septal furrows are shallow.

Median section.—Sectioned adult specimens show from five to six volutions. The average heights of the successive volutions from the first to the sixth whorl are .06, .08, .13, .20, .26, .29 mm. The septal count per volution in the one median section made from the first to the fifth whorl respectively are 10, 14, 16, 23, 24. The two proloculi measured are .15 mm. and .14 mm. in outside diameter. The average thicknesses of the wall in successive whorls from the first to sixth whorl are .02, .03, .04, .05, .07, .075 mm. The height of the chamber cavity is about four times the thickness of the wall in the last whorls. The wall is composed of a thin tectum and is conspicuously coarse alveolar keriotheca, which has ten alveoli in from .180 mm. to .200 mm. and averages ten in .190 mm., as measured in the later whorls.

The septa are like those of other species of the genus.

Axial section.—The fluting is strong in the middle of the chambers and strong to intense in the ends. In the one axial section made, chomata were observed in four whorls on one side of the proloculum and in only one whorl on the other. The tunnel angle measures 22.5° and 27° for the first whorl, 25.5° for both second and third, and 32° for the fourth. Septal pores are few and small.

Comparisons.—The amount of material and number of sections made are at an almost absolute minimum, and in general not sufficient, for specific determination, except possibly when identification seems so certain. It is hardly possible to confuse this species with any other, yet its similarity to *Triticites longissimoideus* (Beede) is commonly mentioned, from which it is differentiated by its smaller size and smaller proloculum. This species is similar to its questionable variety from the Coleman Junction limestone, but is differentiated from it under the description of the latter.

Figured specimens.—Bureau of Economic Geology Coll. Nos. 11780–11782 from Sta. 185–T–3.

TRITICITES EMACIATUS (Beede) var.?

Pl. III, figs. 7–9

Material collected.—An abundance of tests of this varietal form have been collected from the Coleman Junction limestone, top of Putnam formation, just east of Chautauqua, Callahan County (Sta. 30–T–15), by M. E. Upson.

Exterior.—Test is of medium size for the genus; adult forms are from 1.5 mm. to 2.2 mm. in diameter and from 4.8 mm. to 8.0 mm. in length. The form ratio for adult specimens varies from 1:2.9 to 1:3.9 and averages 1:3.4. An ontogenetic series of twenty specimens shows a rather rapid increase of form ratio with growth:

STAGE	DIAMETER *mm.*	LENGTH *mm.*	FORM RATIO Variation	Average
Young	.6–1.3	1.6–4.2	1:2.6–1:3.7	1:3.0
Adult	1.5–2.2	4.8–8.0	1:2.9–1:3.9	1:3.4
Gerontic	2.1–2.3	8.5–9.4	1:4.0–1:4.1	1:4.1

The shape of the test is elongate-elliptical with broadly rounded to bluntly pointed ends, a straight axis, and gently convex lateral slopes. The antetheca is higher at the ends than in the middle of the chambers. The septal furrows vary from shallow to deep.

Median section.—Sectioned adult specimens show from six to seven volutions. The average heights of the successive volutions from the first to seventh whorl are .035, .06, .08, .13, .195, .25, .25 mm. The average number of septa per volution from the first to the sixth whorl respectively are 10, 15, 18, 22, 23, 26, with individual variations of from 14 to 16 in the second whorl, 16 to 19 in the third, 22 to 24 in the fifth, the other whorls showing no variation. Of the four proloculi measured, two are .06 mm. and two .12 mm. in outside diameter. The average thicknesses of the wall in successive whorls from the first to the seventh whorl are .01, .02, .025, .03, .04, .06, .06 mm. The height of the chamber cavity in the last whorls is approximately four times the thickness of the wall. The wall is composed of a thin tectum and a conspicuously alveolar keriotheca, which has ten alveoli in .120 mm. to .140 mm. and averages ten in .125 mm., as measured in the last whorls.

The septa are like those in other species of the genus.

Axial section.—The fluting is moderate to strong in the middle of the chambers and strong to intense in the ends. In the thin sections chomata are discernible in only the first two whorls. The tunnel angle for the first whorl averages 28°, for the second 43°, with an individual variation of from 19° to 38° in the first whorl and 31.5° to 54° in the second. Several septal pores were observed in almost every chamber in the thin sections.

Comparisons.—Though obviously related to *Triticites emaciatus* (Beede), this variety is distinctive in its less height of volution, thinner walls, and a finer alveolar structure, unusually fine for a form so high in the column. The chomata are not developed in as late whorls as in the more characteristic form of the species. The difference in height of volution and thickness of wall would not be noticeable if the first whorl were disregarded, giving this possible variety and the species the same number of volutions.

Figured specimens.—Bureau of Economic Geology Coll. Nos. 11783–11785 from Sta. 30–T–15.

TRITICITES IRREGULARIS (Schellwien and Staff), First Form

Pl. IV, figs. 1–3

Fusulina centralis var. *irregularis* Schellwien and Staff (part), 1912, Palaeontographica, vol. 59, p. 178, pl. 17, figs. 10, 11. (Kansas.)

Triticites irregularis Dunbar and Condra, 1927, Nebr. Geol. Survey Bull. 2, ser. 2, p. 108, pl. 8, figs. 7–10; pl. 9, figs. 1–3. (Kansas, Nebraska, Missouri, Texas.)

Material collected.—Material carrying this first form of the species in abundance was collected from the Brownwood shale about 60 feet below the Adams Branch limestone, Graford formation, along Highway 1A, 3.2 miles by road west of Wink City and in Metcalf Gap, Palo Pinto County (Sta. 181–T–14).

Exterior.—Test is of medium size and rather slender; adult forms are from 1.2 mm. to 1.9 mm. in diameter and from 4.7 mm. to 7.0 mm. in length. The form ratio for the adult specimens varies from 1:3.2 to 1:4.3 and averages 1:3.6. An ontogenetic series of over thirty specimens shows the usual steady increase of form ratio with growth:

STAGE	DIAMETER	LENGTH	FORM RATIO	
	mm.	*mm.*	Variation	Average
Young	.5–1.5	1.4–4.4	1:2.5–1:3.4	1:3.0
Adult	1.2–1.9	4.7–7.0	1:3.2–1:4.3	1:3.6
Gerontic	1.7–2.0	7.6–8.5	1:3.9–1:4.5	1:4.3

The shape is subcylindrical to elongate fusiform with broadly rounded or truncate ends, straight or slightly curved axis, and gently convex lateral slopes. The antetheca remains of uniform height throughout most of its length, but at the ends it becomes higher. Septal furrows are shallow.

Median section.—Adult individuals have five and one-half to seven volutions. The average heights of the successive volutions from the first to the seventh whorls are .05, .07, .09, .13, .165, .205, .25 mm. The average number of chambers per whorl from the first to the fifth whorl respectively are 9, 11, 14, 17, 19. The septal count per whorl varies from 8 to 10 in the first, 10 to 11 in the second, 13 to 15 in the third, 16 to 17 in the fourth, and 18 to 19 in the fifth. The proloculum varies from .085 mm. to .180 mm. in outside diameter. The average thicknesses of the wall in successive whorls from the first to the seventh whorl are .015, .02, .03, .04, .05, .07, .08 mm. The height of the chamber cavity in the later whorls is about three times the thickness of the wall. The wall is composed of a thin tectum and, for the genus, a rather weakly alveolar keriotheca, which has 10 alveoli in .110 to .145 mm. and averages ten in .125 mm., as measured in the last whorls.

The septa are like those in other species of the genus but are quite regular, due to lack of fluting and of thickening by chomata.

Axial section.—The fluting is obsolescent or absent in the middle of the chambers and moderate at the ends. The chomata are strong in the early chambers but weak to obsolescent in the late chambers, often being absent in the last whorl. The average tunnel angles for each whorl from the first to the sixth whorls successively are 26°, 33°, 45°, 52.5°, 54.5°, 58°, with individual variations of 19° to 36°, 23° to 46°, 27° to 66°, 34° to 79°, 37.5° to 74.5°, 56° to 60°. Septal pores are rare and small and are lacking in some tests.

Comparisons.—*Triticites irregularis* (Schellwien and Staff) shows considerable variation in both its stratigraphic and its geographic range. The various forms of the species, of which four are described in this paper, might properly be designated by varietal names. It is difficult to determine from the literature, however, which form is the typical species. As it is not the purpose of this paper to complicate the matter further, all forms are included under the species. *Triticites exiguus* (Shellwien and Staff) is not readily separable, by means of the literature, from *T. irregularis.* The first form here described, as well as the second form of the species in the Palo Pinto limestone may be closely allied to *T. exiguus.* This first form from the Brownwood shale in Texas is selected by Dunbar and Condra as the typical species. It differs from the lower one of the two Palo Pinto forms (second form) in lacking both the undulations of radial expansion and contraction that succeed each other from middle to end and the central swelling, possessed by so many tests of that Palo Pinto form. The height of antetheca is more even than in the other forms.

Figured specimens.—Bureau of Economic Geology Coll. Nos. 11792–11794 from Sta. 181–T–14.

TRITICITES IRREGULARIS (Schellwien and Staff), Second Form

Pl. IV, figs. 4–6

Material collected.—This second form of the species was found in abundance in a shale seam in the Palo Pinto limestone in the quarry of the Mineral Wells Crushed Stone Co. three miles east-southeast of Oran, Palo Pinto County (Sta. 181–T–41).

Exterior.—Test is of small to medium size and rather slender; adult forms are from 1.0 mm. to 1.5 mm. in diameter, and from 3.6 mm. to 5.4 mm. in length. The form ratio for the adult specimens varies from 1:3.1 to 1:4.5 and averages 1:3.7. An ontogenetic series of over thirty specimens shows a steady increase of form ratio with growth:

STAGE	DIAMETER	LENGTH	FORM RATIO	
	mm.	*mm.*	Variation	Average
Young	.4– .9	1.1–3.0	1:2.1–1:3.8	1:3.1
Adult	1.0–1.5	3.6–5.4	1:3.1–1:4.5	1:3.7
Gerontic	1.3–1.7	6.1–6.7	1:3.8–1:4.6	1:4.4

The shape is subcylindrical to elongate-fusiform and many tests have a central swelling, frequently with undulations of radial expansions and contractions that succeed each other from middle to pole. The test has a straight or slightly curved axis, gently convex lateral slopes, and broadly to sharply rounded or truncate ends. Septal furrows are distinct, slightly depressed, and lie in direct lines from end to end of the test or swing forward and backward. The antetheca is of uneven height, low in the middle and much higher at the ends.

Median section.—Adult individuals have six and one-half to seven volutions. The average heights of the successive volutions from the first to the seventh whorl are .03, .04, .06, .08, .12, .18, .18 mm. The average number of chambers per whorl from the first to the seventh respectively are 9, 12, 14, 15, 21, 21, 25, with individual variations of 13 to 14 in the third, 14 to 16 in the fourth, 20 to 21 in the fifth, and 19 to 23 in the sixth. The small proloculum varies from .07 mm. to .09 mm. in outside diameter. The thickness of the wall in successive whorls from the first to the seventh whorl averages .01, .01, .02, .03, .035, .05, .05 mm. The height of the chamber cavity in the last whorls is about three and one-half times the thickness of the wall. The wall is composed of a thin tectum and, for the genus, a rather inconspicuously alveolar keriotheca, which has ten alveoli in .130 to .150 mm. and averages ten in .140 mm. in the last whorls.

The septa are normal for the genus.

Axial section.—The fluting is obsolescent in the middle of chambers and moderate at the ends. The chomata are strong to moderate in the first four chambers but become weak and even obsolete in the later ones. The tunnel is not visible from the outside of specimens. The average tunnel angles from the first to the sixth successively are 18°, 20°, 30°, 38°, 47°, 56.5° and individual variations in the first five whorls in the same order are, 13° to 21°, 15.5° to 30°, 20° to 37.5°, 27° to 46°, 43° to 52°. Very few septal pores were observed in the thin sections.

Comparisons.—This second form of the species is compared with the first one from the Brownwood shale under the description of the latter. This is the form most nearly like the one soon to be described under this specific name from the Anadarche limestone of the Ardmore Basin, Oklahoma. This form of the species differs from both the third form in the top of the Palo Pinto limestone (about eight feet higher) and from the fourth form in the Keechi Creek shale in its less height of volution and its smaller size of proloculum. It is differentiated further from the third form by its thinner wall and lower septal count per whorl. This second form shows an irregularity in the growth of the test not exhibited by the other forms of the species.

Figured specimens.—Bureau of Economic Geology Coll. Nos. 11795–11797 from Sta. 181–T–41.

TRITICITES IRREGULARIS (Schellwien and Staff), Third Form

Pl. IV, figs. 7–9

Material collected.—The third form of this species has been found in the uppermost strata of the Palo Pinto limestone exposed in the quarry of the Mineral Wells Crushed Stone Co. three miles east-southeast of Oran, Palo Pinto County (Sta. 181–T–41).

Exterior.—Test is of medium size and rather slender; adult forms are from 1.6 mm. to 2.3 mm. in diameter and from 4.9 mm. to 8.0 mm. in length. The form ratio of the adult specimens varies from 1:3.0 to 1:3.7 and averages 1:3.5. An ontogenetic series of twenty-five specimens shows a steady increase in form ratio with growth:

STAGE	DIAMETER	LENGTH	FORM RATIO	
	mm.	*mm.*	Variation	Average
Young	.7–1.3	2.0– 4.3	1:2.4–1:3.2	1:2.6
Adult	1.6–2.3	4.9– 8.0	1:3.0–1:3.7	1:3.5
Gerontic	2.2–2.6	8.7–10.0	1:3.5–1:4.0	1:3.8

The shape is subcylindrical to elongate-fusiform with straight to slightly curved axis, gently convex slopes, and broadly rounded or truncated ends. The preservation has made the character of the septal furrows hard to determine, but they are probably flush or shallow. The antetheca increases in height from the middle to the ends.

Median section.—Adult individuals have from six and one-half to seven volutions. The average heights of the successive volutions from the first to the seventh whorl are .06, .075, .105, .145, .20, .25, .305 mm. The average number of septa per whorl from the innermost to the outer whorls respectively are 12, 23, 23, 26, 29, 27. The septal count for the third whorl varies from 21 to 25, for the fourth whorl from 25 to 26, for the fifth from 28 to 30. The proloculum is large for the species, varying from .135 mm. to .245 mm. in outside diameter, although but one exceeds .160 mm. The average thicknesses of the wall in successive whorls from the first to the seventh whorl are .02, .025, .03, .045, .06, .065, .08. The height of the chamber cavity in the later whorls is almost four times the thickness of the wall. The wall is composed of a thin tectum and an alveolar keriotheca, which has ten alveoli in .130 mm. to .170 mm. in the later whorls and averages ten in .155 mm.

The septa are like those in other species of the genus.

Axial section.—The fluting is obsolescent in the middle of the chambers and moderate to strong at the ends. The chomata are strong except in the last part of the test where they may be weak or even absent. The tunnel is not visible from the outside of specimens. The average tunnel angles for successive whorls from the first to the sixth are 18°, 18°, 23.5°, 35°, 51°, 58°, and the successive individual variations are 15° to 21°, 16° to 20°, 18.5° to 28°, 27° to 42.5°, 40° to 60°, 56° to 60.5°. Very few septal pores were observed in the thin sections.

Comparisons.—This third form of the species is more closely allied to the fourth form in the Keechi Creek shale and belongs somewhat doubtfully to this species. It is compared with the other forms of the species under the descriptions of those forms.

Figured specimens.—Bureau of Economic Geology Coll. Nos. 11798–11800 from Sta. 181–T–41.

TRITICITES IRREGULARIS (Schellwien and Staff), Fourth Form

Pl. IV, figs. 10–18

Material collected.—Samples containing the fourth form of this species have been collected from three outcrops:

1. Lower Gaptank formation (Bed No. 6 of P. R. King, Univ. Texas Bull. 3038) two and one-half to three miles southeast of Gap Tank, Glass Mountains, Pecos County (Sta. 185–T–12). The tests are abundant in this exposure. (M. E. Upson, collector.)
2. Keechi Creek shale, Mineral Wells formation, from 60 to 75 feet below the base of the Palo Pinto limestone north of Union School and six miles north of Mineral Wells, Palo Pinto County (Sta. 181–T–43). In this shale zone the fourth form of this species is abundant.
3. East Mountain shale, Mineral Wells formation, just below the Lake Pinto sandstone one mile in direct line northeast of Mineral Wells, Palo Pinto County (Sta. 181–T–79). Both this form and *Triticites* sp. A are rare at this locality.

Exterior.—Test is of medium size; adult forms are 1.0 mm. to 2.3 mm. in diameter and 3.7 mm. to 8.5 mm. in length. The form-ratio varies from 1:3.1 to 1:4.8 and averages 1:3.4 for the first sample, 1:3.6 for the second, and 1:3.3 for the third. Ontogenetic series of thirty-one specimens in the first sample, thirty-one in the second and six in the third show an increase of form ratio with growth:

STAGE	DIAMETER mm.	LENGTH mm.	FORM RATIO Variation	Average
First sample—				
Young	.7–1.2	2.0–3.5	1:2.7–1:3.1	1:3.0
Adult	1.0–2.2	3.7–6.9	1:3.1–1:4.1	1:3.4
Gerontic	1.8–2.2	7.3–8.0	1:3.6–1:4.1	1:3.9
Second sample—				
Young	.6–1.1	1.5– 3.1	1:2.4–1:3.1	1:2.8
Adult	1.2–2.0	4.1– 7.5	1:3.4–1:4.8	1:3.6
Gerontic	1.9–2.4	8.0–10.6	1:3.5–1:4.4	1:4.1
Third sample—				
Adult	2.2–2.3	6.9–8.5	1:3.1–1:3.7	1:3.3

The shape of the test is subcylindrical to elongate-fusiform with broadly rounded to sharply rounded or truncate ends. The axis is straight or slightly curved. The lateral slopes are gently convex. Septal furrows are shallow to deep. The antetheca increases in height from the middle to the ends of the chambers.

Median section.—Adult individuals have five to seven and one-half volutions. The average heights of the successive volutions in specimens of the first sample from the first to the last whorl are .05, .06, .085, .14, .19, .235, .31 mm.; in the second, .04, .05, .08, .13, .21, .27, .28 mm.; in the third, .045, .065, .09, .155, .24, .26, .29 mm. The number of septa per volution from the first to the sixth whorl in specimens of the first sample are 11, 16, 18, 23, 24, 26, with individual variations of 9 to 12 in the first, 13 to 18 in the second, 15 to 21 in the third, 20 to 24 in the fourth, 22 to 25 in the fifth, and 24 to 27 in the sixth. In specimens of the second sample the septal counts are 12, 15, 18, 21, 24, 27, with individual variations of 11 to 13, 14 to 16, 16 to 21, 19 to 23, 23 to 24, and no variation in the sixth. In specimens of the third sample the septal counts are 10, 14, 17, 19, 20, 21, 19, with individual variations of 8 to 12, 13 to 15, 14 to 19, 17 to 21, no variation for fifth, 18 to 24, and a single count of 19 for the seventh.

The proloculum varies from .090 mm. to .160 mm. in outside diameter.

The average thicknesses of the wall in successive whorls from the first to the seventh whorl in specimens of the first sample are .015, .02, .025, .04, .05, .065, .07 mm. In specimens of the second sample they are .01, .015, .02, .03, .04, .05, .07, .06 mm. In specimens of the third sample they are .015, .02, .02, .03, .045, .06, .06 mm.

The height of the chamber cavity in the last whorl is approximately four times the thickness of the wall.

The wall is composed of a thin tectum and an alveolar keriotheca. In the first sample the alveoli are conspicuous; in the other two samples they are weak. In the first sample the alveoli are spaced .120 mm. to .170 mm. and average ten in .155 mm. In the second sample there are ten alveoli in .110 to .120 mm., averaging ten in .110 mm. In the third sample there are ten alveoli in .095 mm. to .120 mm., averaging ten in .105 mm.

The septa are like those of other species of the genus.

Axial section.—The fluting is moderate to obsolescent in the middle of the chambers and moderate at the ends. The chomata are strong practically throughout. The tunnel is not visible from the outside of specimens. The average tunnel angles from the first to the sixth whorl of specimens of the first sample are successively 16°, 19°, 24°, 29.5°, 42.5°, 51°, with individual variations of 13° to 21° in the first, 9° to 28° in the second, 16° to 28° in the third, 24° to 38° in the fourth, 27° to 57.5° in the fifth, and 45° to 61° in the sixth. Measurements of tunnel angles in specimens of the second sample are, 19.5°, 22°, 29°, 38°, 45°, 51°, with individual variations of 16° to 24°, 14° to 29°, 21° to 36.5°, 28° to 52°, 32° to 59°, 46° to 55°. For specimens of the third sample these measurements are 23°, 21.5°, 29°, 41.5°, 48°, with individual variations of, 20° to 30°, 18° to 28°, 21° to 43°, 27° to 59°, 36° to 64°. Septal pores are few and small.

Comparisons.—This fourth form is the largest of the species. It is compared with the Brownwood shale form and with the lower form in the Palo Pinto limestone (first and second forms) under the description of each. It resembles rather closely a yet-unnamed manuscript variety of the species described by Galloway and Ryniker. It differs from the higher of the two Palo Pinto forms (third form) in the lower height of volution, smaller septal count, thinner wall, and smaller proloculum. Practically the only difference between the specimens of the three samples is the spacing of the alveoli.

Figured specimens. — Bureau of Economic Geology Coll. Nos. 11801–11803 (first sample) from Sta. 185–T–12; Nos. 11804–11806 (second sample) from Sta. 181–T–43; and Nos. 11807–11809 (third sample) from Sta. 181–T–79.

TRITICITES LONGISSIMOIDEUS (Beede)

Pl. III, figs. 10–15

Fusulina longissimoidea Beede, 1916, Ind. Univ. Studies, vol. 3, No. 29, p. 15. (Kansas.)
Fusulina longissimoidea, Beede and Kniker, 1924, Univ. Texas Bull. 2433, pl. 1, fig. 10. (Kansas.)
Fusulina longissimoidea, Dunbar and Condra, 1927, Nebr. Geol. Survey Bull. 2, ser. 2, p. 114, pl. 10, figs. 4–9. (Kansas, Oklahoma.)

Material collected.—Specimens of this species have been found in two samples from Glass Mountains:

1. Upper Gaptank formation, at Gap Tank, Pecos County (Sta. 185–T–3). (Fielding Bohart, collector.)
2. Lower Wolfcamp formation, north of Wolf Camp and about one mile west of Ramsey (old Taylor) ranch house, Brewster County Sta. 22–T–139). (M. E. Upson, collector.) In these same strata *Schwagerina gigantea* M. P. White n.sp. and *S. uddeni* Beede and Kniker also occur.

Exterior.—Only twelve specimens from the first sample have been available, and all were used in this study. From the second sample about fifty specimens were found, and eleven of these were used. The tests from the first sample are adult; those from the second are young and adult. A tabulation of measurements of these specimens follows:

STAGE	DIAMETER *mm.*	LENGTH *mm.*	FORM RATIO Variation	FORM RATIO Average
First sample—				
Adult	1.5–2.7	6.4–10.0	1:3.4–1:5.1	1:4.0
Second sample—				
Young	2.1–2.7	6.0– 7.6	————	1:2.8
Adult	3.2–4.0	10.2–15.6	1:3.3–1:4.1	1:3.7

The test is rather large for the genus. Those of the second sample are much larger than those of the first. Although some variation exists between the specimens of the two samples, they are both assigned to the species without even varietal distinction. The specimens from the first sample may more closely match the typical form.

The shape of the test is subcylindrical with broadly rounded ends, straight axis, and gently convex lateral slopes. The antetheca increases in height from the middle to the ends of the test. The septal furrows are shallow.

Median section.—Adult specimens of the first sample are composed of five to six and one-half volutions; those of the second sample, six to seven volutions. The average heights of the successive volutions in specimens of the first sample from the first to the sixth whorl respectively are .09, .105, .16, .22, .29, .345 mm. The same measurements in specimens of the second sample are .08, .12, .21, .26, .315, .36, .40 mm. The number of septa per whorl in the first to the fifth whorl of the single thin section of a specimen from the first sample are 9, 19, 23, 25, 29. In specimens of the second sample the average number of septa per whorl in successive whorls are 12, 18, 23, 33, 35, 36, with individual variations of 17 to 19 in the second, 22 to 23 in the third, 32 to 33 in the fourth, 33 to 36 in the fifth, and a single count of 36 for the sixth.

The proloculum is large for the genus. Three measurements of .190 mm., .250 mm., and .260 mm. for the outside diameter have been made from sections of specimens from the first sample; four measurements of .220 mm., .240 mm., .240 mm., .280 mm. in specimens of the second sample.

The average thicknesses of the wall in successive whorls from the first to the sixth whorl of specimens of the first sample are .025, .03, .05, .06, .07, .08 mm. The same measurements for the seven successive whorls of specimens of the second sample are .02, .04, .05, .07, .10, .11, .11 mm. The height of the chamber cavity in the last whorls of specimens of both samples is from three to four times the thickness of the wall.

The wall is composed of a thin tectum and a conspicuously coarse alveolar keriotheca. In specimens of the first sample ten alveoli occupy from .170 mm. to .200 mm., as measured in the last whorls, with an average of ten in .180 mm. In specimens of the second sample ten alveoli occupy from .160 mm. to .220 mm., with an average of ten alveoli in .190 mm.

The septa are like those of other species of the genus.

Axial section.—The fluting is strong in the middle and intense in the ends of the chambers of all thin sections from both samples. In specimens of the first sample weak chomata were traced into the third whorl; in specimens of the second sample, as far as the fifth. The average tunnel angles from the first to the third whorl of specimens of the first sample are successively 20°, 30°, 35°, with individual variations of 18° to 21° in the first whorl, 29° to 31°

in the second, and 26° to 41° in the third. The average tunnel angles from the first to the fifth whorl of specimens from the second sample are 28°, 26°, 30°, 34°, 45°, with individual variations of 22° to 34° in the first whorl, 22° to 32° in the second, 23° to 41° in the third, 24° to 45° in the fourth, and 33° to 50° in the fifth. Very few septal pores were observed in any of the sections made from either sample.

Comparison. — This form is unlikely to be confused with any other, though following the usual practice it is compared with *Triticites emaciatus* (Beede) under the description of that species.

Figured specimens. — Bureau of Economic Geology Coll. Nos. 11786–11788 (first sample) from Sta. 185–T–3, and Nos. 11789–11791 (second sample) from Sta. 22–T–139.

TRITICITES MOOREI Dunbar and Condra

Pl. V, figs. 1–9

Triticites moorei Dunbar and Condra, 1927, Nebr. Geol. Survey Bull. 2, ser. 2, p. 99, pl. 1, fig. 3; pl. 9, fig. 4; pl. 11, figs. 1–5. (Graham formation, South Bend shale member, Texas.)

Material collected.—An abundance of tests of this species have been collected from the calcareous shale just below the Gunsight limestone ledge near the top of a steep slope below the dam on Salt Creek upstream from the bridge on the Graham-Breckenridge road and about one mile west of Graham, Young County (Sta. 251–T–2), the type locality for the species. *Triticites plummeri* Dunbar and Condra and *T. plummeri* var.? occur abundantly in this same bed.

Three separate samples taken from this bed are treated separately in the following description.

Exterior.—Test is of medium size for the genus; adult forms are 1.5 mm. to 2.4 mm. in diameter and 4.3 mm. to 6.3 mm. in length. The form ratio for the adult specimens varies from 1:2.3 to 1:3.2 and averages 1:2.8. An ontogenetic series of over fifty specimens from each of three samples shows that the form ratio increases steadily with growth:

STAGE	DIAMETER mm.	LENGTH mm.	FORM RATIO Variation	Average
First sample—				
Young	.5–1.5	1.0–4.1	1:1.9–1:3.0	1:2.4
Adult	1.6–2.4	4.7–6.2	1:2.5–1:3.1	1:2.8
Gerontic	2.0–2.4	6.9–7.3	1:3.0–1:3.4	1:3.2
Second sample—				
Young	.6–1.3	.9–3.4	1:1.5–1:2.6	1:2.2
Adult	1.5–2.4	4.3–6.3	1:2.6–1:3.2	1:2.8
Gerontic	2.1–2.4	6.6–7.0	1:2.8–1:3.2	1:3.1
Third sample—				
Young	1.7–1.9	3.8–4.5	1:2.2–1:2.4	1:2.4
Adult	2.0–3.0	5.2–6.1	1:2.3–1:3.0	1:2.8

The shape is elliptical with blunt to broadly rounded ends, straight axis, and gently convex lateral slopes. Septal furrows are deep. The antetheca is higher at the ends.

Median section.—Adult individuals have from six to seven volutions. The average heights of the successive volutions in the first to the seventh whorls in the specimens from the three samples respectively are .04, .065, .10, .17, .23, .27, .28 mm.; .04, .055. .10, .15, .22, .29, .30 mm.; and .04, .065, .10, .14, .19, .28, .30 mm. The average number of chambers in successive volutions from the first to the sixth whorl in specimens from the three samples respectively are 13, 16, 17, 17, 20, 26; 10, 15, 15, 19, 21, 23; and 12, 15, 17, 17, 19, 21. The number of chambers in the first whorl varies from 10 to 15, in the second 13 to 16, in the third 15 to 17, in the fourth 16 to 21, in the fifth 18 to 22, and in the sixth 21 to 26. The proloculum is small for the genus and ranges in diameter from .15 to .16 mm. in the first sample, .095 to .125 mm. in the second sample, and .14 to .145 mm. in the third sample, only one specimen falling below .12 mm. The average thicknesses of the wall in successive whorls from the first to the seventh in the three samples respectively are .015, .02, .03, .04, .05, .06, .07 mm.; .01, .015, .025, .035, .055, .08, .08 mm.; and .015, .02, .02, .04, .055, .075, .08.mm. The height of the chamber cavity in the seventh whorl is about four times the thickness of the wall. The wall is composed of a thin tectum and a conspicuously alveolar keriotheca, which has ten alveoli in .115 to .180 mm. in the sixth whorl and averages ten in .150 mm. As in all fusulinid tests the alveoli become coarser and more distinct from the inner whorls outward.

The septa are thin, in general from about half the thickness of the wall to much less, show little or no inward tapering except where thickened by the chomata, and may be somewhat bulbose.

The tectum turns abruptly inward from the wall at almost a right angle and is thickened by a clear, granular deposit on the inside soon after it has become the septum. The keriotheca is thicker on both sides of the septum, and the alveoli spread away from the septum. The septa reach about two-thirds of the way to the floor of the chambers in the middle of the tunnel in the inner whorls and extend closer to the floor in the outer whorls, until in well-preserved individuals the last one or two reach the floor. From the sides of the tunnel to the ends of the test the septa extend to the floor. Though individual septa may be bent backward toward the proloculum, or be virtually at right angles to the wall, in general they point a few degrees outward.

Axial section.—The fluting is obsolescent in the middle of the chambers, and strong at the ends. The chomata are moderately developed from the first to the fifth whorl and became weak or obsolescent in the last two. The tunnel is not visible from the outside of specimens. The tunnel angle increases from the first to the last whorl so that the chomata bounding the tunnel, as seen in axial section, make the two curves of a hyperbole rather than an X. The average tunnel angles in successive whorls from the first to the sixth are 16.5°, 23°, 33.5°, 38°, 44° in the first sample, 21°, 22°, 27°, 35.5°, 43°, 47.5° in the second sample, and 25°, 27°, 32°, 37.5°, 40.5°, 46° in the third sample. The successive angles from the first to the sixth whorls vary from 14° to 32.5° in the first, 15° to 32.5° in the second, 25° to 37° in the third, 27° to 48° in the fourth, 31° to 52° in the fifth, and from 46° to 47.5° in the sixth. Septal pores are abundant but vary in number with the individual.

Comparisons.—This species differs from the similar *Triticites cullomensis* Dunbar and Condra in its slightly higher form ratio, thinner walls, more abundant septal pores, deeper septal furrows, a much more uneven height of antetheca, and weaker chomata. The specimens described by Dunbar and Condra from this same locality are smaller and have fewer whorls.

Figured specimens.—Bureau of Economic Geology Coll. Nos. 11810–11812 (first sample); Nos. 11813–11815 (second sample); and Nos. 11816–11818 (third sample), all from Sta. 251–T–2.

TRITICITES OBESUS (Beede)

Pl. V, figs. 10–18

Fusulina obesa Beede, 1916, Ind. Univ. Studies No. 29, p. 12.
Fusulina obesa Beede and Kniker, 1924, Univ. Texas Bull. 2433, pl. 1, fig. 9.
Triticites obesus Dunbar and Condra, 1927, Nebr. Geol. Survey Bull. 2, ser. 2, p. 102, pl. 9, figs. 9, 10. (Kansas, Oklahoma.)

Material collected.—Specimens of this species have been found in three samples:

1. Shale about ten feet above the *Campophyllum* limestone ledge in an exposure on the Rock Island Railroad under the viaduct 3.7 miles by road southeast of the Jacksboro courthouse, Jack County (Sta. 118–T–8). Both this species and *Triticites acutus* Dunbar and Condra are abundant in a shale bed at the top of this exposure.
2. Shale below Crystal Falls limestone, base of Harpersville formation, 2.85 miles by road southwest of Rockwood, Coleman County (Sta. 42–T–33). (Gayle Scott, collector.)
3. Waldrip beds, probably the equivalent of the Belknap limestone, Harpersville formation, about one and one-half miles southwest of Rockwood, Coleman County (Sta. 42–T–34). (M. E. Upson, collector.)

Specimens from the three samples show considerable variation in size, and those from the third sample are probably dwarfed. Some internal variations are also observed. As only eight specimens were available from the second sample, no attempt has been made to separate adult from gerontic. Despite the differences observed, it has seemed advisable to regard all these forms as belonging to the same species without making varieties.

Exterior.—Tests from all three formations vary from less than medium to full medium size for the genus. Adult specimens of the first sample range from 2.0 mm. to 2.9 mm. in diameter and from 4.4 mm. to 6.1 mm. in length. Specimens of the second sample vary from 2.5 mm. to 3.4 mm. in diameter and from 4.7 mm. to 8.1 mm. in length. Adult specimens of the third sample vary from 1.7 mm. to 2.3 mm. in diameter and from 3.8 mm. to 5.0 mm. in length. The average form ratio of the adult specimens from the first and third samples, and all specimens of the second, is 1:2.2. Ontogenetic series of twenty-one specimens for the first, six for the second, and thirteen for the third sample show a relatively small increase in form ratio with growth:

STAGE	DIAMETER mm.	LENGTH mm.	FORM RATIO Variation	Average
First sample—				
Young	.5–2.0	1.0–3.9	1:1.5–1:2.2	1:1.9
Adult	2.0–2.9	4.4–6.1	1:2.1–1:2.4	1:2.2
Gerontic	2.6–2.7	6.6–8.4	1:2.4–1:2.5	1:2.5
Second sample—				
All	2.5–3.4	4.7–8.1	1:1.9–1:2.4	1:2.2
Third sample—				
Young	1.3–1.7	2.2–3.3	1:1.8–1:2.2	1:2.0
Adult	1.7–2.3	3.8–5.0	1:2.1–1:2.3	1:2.2
Gerontic	2.4	5.9	——	1:2.5

The shape of specimens of the first and third samples is rhomboidal to slightly obese with broadly rounded to bluntly pointed ends, straight axis, and lateral slopes that vary with the individual and even in the same individual from gently convex through straight to concave. The shape of specimens of the second sample is slightly obese with broadly rounded ends, straight axis, and concave lateral slopes. The antetheca is of even height practically throughout its length to slightly higher at the very ends. Septal furrows are flush to shallow.

Median section.—There are from eight to nine whorls in mature specimens of the first sample; nine in specimens of the second; and from six to nine in those of the third. The average heights of the successive volutions from the first to the last whorl of specimens of the first sample are .04, .05, .07, .11, .155, .215, .26, .28, .28 mm.; of specimens of the second sample, .06, .07, .09, .11, .17, .21, .24, .29, .32 mm.; of the third sample, .04, .05, .08, .11, .18, .24, .305, .33 mm. The average number of chambers in successive volutions from the first to the ninth whorl of specimens of the first sample are 12, 15, 19, 23, 23, 25, 26, 28, 26, with individual variations of 13 to 17 in the second, 17 to 20 in the third, 20 to 25 in the fourth, 22 to 29 in the fifth, 24 to 25 in the sixth, and 22 to 29 in the seventh. The same counts in a specimen of the second sample are 14, 18, 21, 25, 28, 35, 34, 39. For the third sample these counts are 10, 15, 19, 23, 22, 25, 25, 28, with individual variations of 13 to 16 in the second whorl, 18 to 19 in the third, 21 to 25 in the fourth, 21 to 22 in the fifth, 23 to 26 in the sixth, and 27 to 29 in the eighth. The proloculum in specimens of the first sample varies in outside diameter from .08 mm. to .10 mm.; in those of the second sample from .11 mm. to .12 mm.; in those of the third sample from .095 mm. to .11 mm.

The average thicknesses of the wall in successive whorls from the first to the ninth whorl of specimens of the first sample are .01, .02, .025, .03, .045, .065, .08, .09, .08 mm. In specimens of the second sample the successive thicknesses are .015, .02, .03, .035, .055, .065, .07, .07, .09 mm. In specimens of the third sample the thicknesses are .015, .02, .035, .04, .06, .08, .09, .09 mm. The height of the chamber cavity in the later whorls of all specimens is about three times the thickness of the wall.

The wall is composed of a thin tectum and a conspicuously alveolar keriotheca. In specimens of the first sample the later whorls show ten alveoli in .140 to .160 mm., and average ten in .150 mm. In specimens of the second sample ten alveoli occupy from .140 mm. to .180 mm. and average ten in .165 mm. In specimens of the third sample they are spaced ten in .155 mm. to .220 mm. and average ten in .180 mm.

The septa are like those of other species of the genus. Due to the pronounced chomata they are often thickened and in places coalesce.

Axial section.—The fluting is obsolescent to moderate in the middle of the chambers and strong at the ends in all specimens. The chomata are massive to strong in practically all whorls, though sometimes weak in the last. The tunnel is visible from the outside of some weathered tests. The average tunnel angles from the first to the eighth whorl in specimens of the first sample are 14°, 15°, 19.5°, 20°, 23.5°, 26°, 28°, 41°, with individual variations of 13° to 14.5°, 12° to 18°, 15° to 25°, 19° to 22°, 21.5° to 26°, 24° to 28.5°, 23° to 32°, and 36.5° to 44.5°. These measurements in specimens of the second sample are 15.5°, 12.5°, 12.5°, 18°, 14.5°, 20.5°, 21.5°, 31°, with individual variations of 14° to 17°, 11° to 13.5°, 11° to 14°, 16° to 20°, 10° to 19°, 18° to 23°, 18° to 25°, and 23° to 39°. In specimens of the third sample these successive angles are 18°, 16.5°, 16°, 19.5°, 20°, 27°, with individual variations of 15.5° to 21°, 13° to 23°, 12° to 21°, 14° to 25°, 15° to 26.5°, and no variation noted for the sixth. Septal pores are very few and small.

Comparison.—This species can hardly be confused with any of the other forms.

Figured specimens.—Bureau of Economic Geology Coll. Nos. 11819–11821 (first sample) from Sta. 118–T–8; Nos. 11822–11824 (second sample) from Sta. 42–T–33; and Nos. 11825–11827 (third sample) from Sta. 42–T–34.

TRITICITES PLUMMERI Dunbar and Condra

Pl. VI, figs. 1–6; Pl. IX, figs. 1–3; Pl. X, figs. 1–3

Triticites plummeri Dunbar and Condra, 1927, Nebr. Geol. Survey Bull. 2, ser. 2, p. 98, pl. 6, figs. 1–6. (Graham formation, South Bend shale member, Texas.)

Material collected.—An abundance of specimens of this species was collected from the calcareous shale just below the Gunsight limestone ledge near the top of a steep slope below the dam on Salt Creek upstream from the bridge on the Graham-Breckenridge road and about one mile west of Graham, Young County (Sta. 251–T–2), the type locality for this species. A variety of this species and *Triticites moorei* Dunbar and Condra occur in this same layer.

Two samples from this bed yielded specimens of this species, and each group of specimens is treated separately in the following descriptions.

Exterior.—Test is of medium size for the genus; adult forms are 2.2 mm. to 4.3 mm. in diameter and 3.2 mm. to 5.7 mm. in length. The form ratio for the adult specimens varies from 1:1.2 to 1:1.5 and averages 1:1.4. An ontogenetic series of thirty specimens from two samples shows a slight but steady increase of form ratio with growth:

STAGE	DIAMETER *mm.*	LENGTH *mm.*	FORM RATIO Variation	FORM RATIO Average
First sample—				
Young	.6–2.4	.7–2.9	1:1.2–1:1.5	1:1.3
Adult	2.2–4.3	3.2–5.7	1:1.2–1:1.5	1:1.4
Gerontic	4.0–4.5	7.0–8.5	1:1.6–1:1.9	1:1.7
Second sample—				
Young	2.0	2.7–3.0	1:1.2–1:1.5	1:1.3
Adult	3.3–3.6	4.6–5.1	1:1.3–1:1.5	1:1.4

The shape is inflated with broadly to obtusely pointed ends, straight axis, and convex lateral slopes. Septal furrows are shallow. The antetheca is of even height.

Median section.—Adult individuals have seven and one-half to nine and one-half volutions. The average heights of the successive volutions from the first to the first half of the tenth volution in specimens from the two samples respectively are .04, .05, .09, .15, .22, .25, .36, .38, .40, .34 mm. and .02, .045, .07, .13, .20, .295, .35, .42 mm. The average number of chambers per whorl from the first to the eighth whorl is 12, 15, 17, 23, 30, 33, 36, 40, with individual variations of 10 to 13 in the first whorl, 14 to 16 in the second, 15 to 19 in the third, 21 to 25 in the fourth, 27 to 33 in the fifth, 30 to 36 in the sixth, 34 to 39 in the seventh, and 39 to 41 in the eighth. The proloculum is very small and varies from .050 to .070 mm. The average thicknesses of the wall in successive whorls from the first to the ninth whorl of the two samples respectively are .01, .02, .03, .05, .065, .09, .10, .12, .13 mm. and .01, .01, .02, .03, .045, .065, .09, .11 mm. The height of the chamber cavity in the later whorls is a little more than three times the thickness of the wall. The wall is composed of a thin tectum and a conspicuously alveolar keriotheca, which has ten alveoli in .160 to .200 mm. in the outer whorls and averages ten in .175 mm.

The septa are thin, in general from about half the thickness of the wall to much less, and show little or no inward tapering except where thickened by the chomata, which make them bulbose or tapering or even make the septa appear to coalesce. The tectum turns abruptly inward from the wall at nearly a right angle and is thickened by a clear, granular deposit on the inside soon after it has become the septum. The keriotheca is thicker on both sides of the septum, and the alveoli spread away from the septum on both sides. The septa reach about two-thirds of the way to the floor of the chamber in the middle of the tunnel in the inner whorls and extend closer to the floor in the outer whorls; in well-preserved specimens the last one or two septa reach to the floor. From the sides of the tunnel to the ends of the test the septa extend to the floor. Though individual septa may be bent backward toward the proloculum or be virtually at right angles to the wall, in general they point a few degrees outward.

Axial section.—The fluting is moderate in the middle of the chambers and strong at the ends. The chomata are strong practically throughout the test, though they may be moderate, weak, or even obsolescent in the last one or two chambers. The tunnel is not visible from the outside of specimens. The tunnel angle is very narrow, increases but little from the inner to the outer whorls, and generally, but not always, following a tortuous route, especially in the inner whorls. This tortuous tunnel, caused by a shifting back and forth along the axis, is especially prominent in the more globular specimens and accounts in part for the more globular form. The average angles for successive whorls from the innermost outward are 13°, 11°, 14°, 11°, 13.5°, 18°, 21°, 27°, 27° in specimens of the first sample 18°, 17°, 14°, 16°, 19°, 21° in specimens of the second sample. The individual variations in successive whorls are from 12° to 20°, 9.5° to 20°, 12° to 15°, 8° to 19°, 9° to 19°, 13° to 23°, 18° to 25°, 25° to 29°, and 27°. Septal pores are relatively abundant but small and vary in number with the individual.

Comparison.—With no other form except the following variety can this species be confused.

Figured specimens.—Bureau of Economic Geology Coll. Nos. 11828–11830 (first sample) and Nos. 11831–11833 (second sample), all from Sta. 251–T–2. The specimens figured on Plates IX and X are in the collections of the Gypsy Oil Company, Ardmore, Oklahoma.

TRITICITES PLUMMERI Dunbar and Condra var.?

Pl. VI, figs. 7–9

Material collected.—This rather rare varietal form was collected from the calcareous shale just below the Gunsight limestone ledge near the top of a steep slope below the dam on Salt Creek upstream from the bridge on the Graham-Breckenridge road and about one mile west of Graham, Young County (Sta. 251–T–2). The typical form of *Triticites plummeri* Dunbar and Condra and also *T. moorei* Dunbar and Condra are abundant in this same bed.

Exterior.—Test is of medium size for the genus; adult forms are from 2.4 mm. to 3.9 mm. in diameter and from 4.7 mm. to 7.3 mm. in length. The form ratio for the adult specimens varies from 1:1.8 to 1:2.2 and averages 1:2.0. An ontogenetic series of twenty-three specimens shows a slight but steady increase of form ratio with growth:

STAGE	DIAMETER *mm.*	LENGTH *mm.*	FORM RATIO Variation	Average
Young	.4–2.2	1.0–4.4	1:1.6–1:2.0	1:1.9
Adult	2.4–3.9	4.7–7.3	1:1.8–1:2.2	1:2.0

The shape is ventricose with broadly rounded ends, straight axis, and concave, convex, or straight lateral slopes or any combination of these curvatures. The septal furrows are shallow. The antetheca remains of uniform height to the ends, where it becomes higher.

Median section.—Adult tests have eight to eight and one-half volutions. The measurements of five thin sections show the average heights of the successive volutions from the innermost outward to be .04, .05, .095, .15, .215, .28, .35, .34, and .36 mm. The average number of septa per volution from the first to eighth whorl in two specimens respectively are 10, 13, 18, 21, 21, 26, 32, 30, 11, and 14, 18, 23, 28, 37, 37, 34. The proloculum is small, measuring .10 mm. in outside diameter in four thin sections and .06 mm. in a fifth. The average thicknesses of the wall in successive whorls from the innermost outward respectively are .01, .02, .03, .04, .07, .09, .10, .11, .11 mm. The height of the chamber cavity in the later whorls is somewhat over three times the thickness of the wall. The wall is composed of a thin tectum and a conspicuously alveolar keriotheca, which has ten alveoli in .160 to .190 mm. in the outer whorls and averages ten in .165 mm.

The septa are less than half as thick as the wall and are only slightly thickened by the chomata, though some coalesce. The tectum turns abruptly inward from the wall at nearly a right angle, and is thickened by a clear, granular deposit on the inside, soon after it becomes the septum. The keriotheca is thicker on both sides of the septum, and the alveoli spread away from the septum on both sides. The relations between the septal wall and the floor of the whorl or chamber are like those of the species.

Axial section.—The fluting is moderate in the middle of the chambers and strong at the ends. The chomata are strong throughout the test. The tunnel is not visible from the outside of specimens. The tunnel angle is relatively narrow and flaring but little in the first four whorls and but slightly more from the fourth outward. The tunnel is not tortuous as in some tests of the species, nor is there the corresponding shifting of the axis. Measured in the three thin sections, the average tunnel angles from the first to the seventh whorl are 18.5°, 18°, 20°, 20°, 24.5°, 28°, 33.5°, with individual variations of 14° to 23°, 14° to 22°, 18° to 23.5°, 15.5° to 25°, 14° to 41°, 23° to 35.5°, and from 22° to 40°. Septal pores are common and small and vary in number with the individual. Viewed from the outside the specimens show the porous character of fusuline tests seen in specimens of rare perfect preservation. In most species these pores are the ends of the tubes.

Comparison.—The variety differs from the species in its ventricose rather than inflated shape, in a larger form ratio, increase in height of antetheca at the ends, slightly wider tunnel angle in the outer whorls without the general tortuous coarse or shifting axis, and with a somewhat larger proloculum.

Figured specimens.—Bureau of Economic Geology Coll. Nos. 11834–11836 from Sta. 251–T–2.

TRITICITES SECALICUS (Say)

Pl. VI, figs. 10–12

Miliolites secalicus Say, 1823, Long's Exped. to Rocky Mts., vol. 1, p. 151. (Nebraska or Iowa or both.)

Fuslina secalica Beede (part), 1900, Univ. Kans. Geol. Surv., vol. 6, p. 10.

Triticites secalicus Girty, 1904, Am. Jour. Sci., ser. 4, vol. 17, p. 234.

Fusulina centralis Staff (part), 1912, Paleontographica, vol. 59, p. 175, pl. 16, figs. 1 and 2 (not pl. 17, figs. 1 and 8).

Triticites secalicus, Dunbar and Condra, 1927, Nebr. Geol. Survey Bull. 2, ser. 2, p. 104, pl. 7, figs. 1–7; pl. 8, fig. 6; pl. 11, fig. 7. (Nebraska, Missouri, Iowa, Kansas.)

Material collected.—An abundance of tests of this species have been found in a sample collected from the base of the shale between the upper and lower ledges of the Gunsight limestone in the first escarpment about one-quarter of a mile southwest of Ivan and about one hundred yards north of the Ivan-Breckenridge highway, Stephens County (Sta. 214–T–23).

Exterior.—Test is fairly large for the genus; adult forms are 1.9 mm. to 3.3 mm. in diameter and 5.4 mm. to 10.6 mm. in length. The form ratio for the adult specimens varies from 1:2.6 to 1:3.8 and averages 1:3.2. An ontogenetic series of over twenty-five specimens shows a rapid increase of form ratio with growth:

STAGE	DIAMETER mm.	LENGTH mm.	FORM RATIO Variation	Average
Young	.9–1.8	1.4– 4.4	1:1.6–1:2.9	1:2.3
Adult	1.9–3.3	5.4–10.6	1:2.6–1:3.8	1:3.2
Gerontic	3.0–3.3	10.9–11.9	1:3.3–1:3.9	1:3.6

The shape of the test is ellipsoid with broadly rounded ends, straight axis, and convex lateral slopes. The antetheca increases in height from the middle to the ends. The septal furrows are shallow.

Median section.—Adult individuals are composed of seven to eight volutions. The average heights of the successive volutions from the first to the eighth whorls respectively are .06, .08, .11, .17, .21, .24, .18, .17 mm. The average number of chambers per volution from the first to the seventh respectively are 14, 19, 19, 21, 24, 26, 29, with individual variations of 13 to 14 in the first whorl, no variation in the second, 18 to 19 in the third, 20 to 21 in the fourth, 22 to 25 in the fifth, 23 to 28 in the sixth, and no variation in the seventh. The proloculum in all thin sections made measures .160 mm. in outside diameter. The average thicknesses of the wall in successive whorls from the first to the eighth are .02, .025, .03, .05, .065, .08, .09, .09 mm. Due probably to crushing of specimens, the measured heights of the volutions in the last two whorls is misleading, as is a comparison of the height of the chamber cavity with the wall thickness in these last two whorls. The height of the chamber cavity up to the sixth whorl is about three times the thickness of the wall. The wall is composed of a thin tectum and a conspicuously alveolar keriotheca, which has ten alveoli in .110 mm. to .130 mm. and averages ten in .115 mm., as measured in the last whorls.

The septa are like those of the other species of the genus.

Axial section.—The fluting is obsolescent in the middle of the chambers and strong at the ends. The chomata are strong in the first six whorls but weak to absent in the last two. The tunnel is not visible from the outside of the specimens. The average tunnel angles from the first to the sixth whorl successively are 19°, 28°, 37°, 45°, 63°, 68.5°, with individual variations of 18.5° to 21°, 22° to 32.5°, 27.5° to 42°, 42° to 50°, 55° to 80°, 63.5° to 76°. Septal pores are fairly numerous and small.

Comparisons.—This species is much like *Triticites cullomensis* Dunbar and Condra, which is shorter and possesses a smaller tunnel angle, and its wall has a coarser alveolar texture. The species is compared with *T. acutus* Dunbar and Condra, which it resembles, under that species.

Figured specimens.—Bureau of Economic Geology Coll. Nos. 11837–11840 from Sta. 214–T–23.

TRITICITES TUMIDUS Skinner

Pl. VIII, figs. 7–9

Triticites tumidus Skinner, 1931, Jour. Pal., vol. 5, p. 21, pl. 4, figs. 5–7. (Oklahoma.)

Material collected.—Specimens of this species were collected by Fielding Bohart from the upper Gaptank formation at Gap Tank, Glass Mountains, Pecos County (Sta. 185–T–3).

Exterior.—Test is of medium size for the genus, 3.0 mm. to 3.8 mm. in diameter and 4.6 mm. to 6.5 mm. in length. Its form ratio varies from 1:1.5 to 1:2.1 and averages 1:1.8. Only seven specimens available for examination makes subdivision into various stages uncertain, especially as all these tests belong probably to the adult stage.

The shape of the test is somewhat irregular and variable in different specimens and even within the same specimen. It ranges from ventricose through inflated to highly inflated or almost globular, has broadly to obtusely pointed ends, straight axis, and lateral slopes that vary from convex through straight to concave. The antetheca is of about even height throughout, although the extension of the ends of the last chamber in some specimens makes the height of this wall somewhat greater at the very ends. The specimens examined are so weathered that the character of septal furrows is obscure.

Median section.—Adult specimens show nine to eleven volutions. The average heights of the successive volutions from the first to the eleventh respectively are .045, .06, .09, .125, .15, .17, .22, .25, .25, .27, .32 mm. The average number of septa per volution in the one thin section made from the first to the eighth are 12, 16, 18, 20, 24, 25, 31, 32. The two proloculi measured are .10 mm. and .12 mm. in outside diameter. The average thicknesses of the wall in successive volutions from the first to the eleventh respectively are .015, .03, .03, .04, .05, .055, .06, .07, .075, .08, .08 mm. The height of the chamber cavity is three and one-half to four times the thickness of the wall in the later whorls. The wall is composed of a thin tectum and a conspicuously alveolar keriotheca, which has ten alveoli in .150 mm. to .180 mm. and averages ten in .165 mm., as measured in the later whorls.

The septa are like those of other species of the genus, except that they are usually coalescing and much swollen, due to thickening by the chomata.

Axial section.—Fluting is moderate in the middle and strong in the ends of chambers. Chomata are unusually strong—intense throughout. The great strength of the chomata and weathered condition of the specimens make the tunnel prominent from the outside of specimens. The tunnel angle is very narrow and straight, averages in successive whorls from the first to the tenth, 14°, 14°, 12°, 11°, 14°, 13°, 15°, 17°, 16°, with individual variations of 12° to 16.5° in the first and second, 11° to 12° in the third, 9.5° to 12° in the fourth, 11° to 16° in the fifth, 13° to 14° in the sixth, no variation in the seventh, 13° to 16° in the eighth, 16° to 18° in the ninth, 14° to 17.5° in the tenth. Septal pores have not been observed.

Comparison.—This species is unique and can not possibly be confused with other species.

Figured specimens.—Bureau of Economic Geology Coll. Nos. 11862–11864 from Sta. 185–T–3.

TRITICITES VENTRICOSUS (Meek)

Pl. VII, figs. 1–9

Fusulina cylindrica var. *ventricosa* Meek, 1858, Proc. Acad. Nat. Sci. Philadelphia, vol. 10, p. 261.

Fusulina cylindrica Meek and Hayden (part), 1865, Pal. Upper Missouri, Smithsonian Contrib. to Knowledge, vol. 14, p. 14, pl. 1, figs. 6d–g, (figs. 6a–c are of the variety *meeki*).

Triticites ventricosus Dunbar and Condra, 1927, Nebr. Geol. Surv. Bull. 2, ser. 2, p. 84, pl. 3, figs. 1–6; pl. 4, figs. 1–3; (pl. 4, fig. 4 is of the variety *meeki*; pl. 4, figs. 5 and 6, are of the variety *inflatus*). (Nebraska, Kansas, Missouri.)

Material collected.—Samples containing specimens of the typical form of this species have been collected from two outcrops and three stratigraphic positions:

1. Shale bed about five feet above the upper Gunsight limestone ledge and about 90 feet below the Ivan limestone in the second prominent escarpment along the Ivan-Breckenridge highway about two and one-half miles southwest of Ivan, Stephens County (Sta. 214–T–2). In this same bed *Triticites beedei* Dunbar and Condra var.? is rather rare.
2. Shale about 75 feet above the upper Gunsight limestone ledge and about 20 feet below the Ivan limestone in the same escarpment as above (Sta. 214–T–2). In this same bed *Triticites ventricosus* var. *meeki* (Möller) and *T. beedei* Dunbar and Condra are abundant.
3. Saddle Creek limestone member of the Harpersville formation 6.7 miles by road west of Burch Hotel in Breckenridge on the Albany highway, Stephens County (Sta. 214–T–24). Tests of this species are rather rare in this exposure.

This species shows considerable variation, as a result of which two varieties are recognized in the Texas material studied for this paper and at least two more varieties have been recognized by other workers. The three separate collections containing the typical species are treated separately, so that any noticeable differences in salient characters will be clear.

Exterior.—Specimens in the first two samples are of medium size for the genus; those in the third are unusually large. Only young and adult stages are recognized amongst the specimens of the second sample, because so few are strikingly larger than the average test. Adult specimens of the first sample vary from 2.1 mm. to 3.0 mm. in diameter and from 5.0 to 7.0 mm. in length; the adults of the second sample from 2.8 mm. to 3.9 mm. in diameter and from 6.5 mm. to 8.7 mm. in length; the adults of the third sample from 3.2 mm. to 4.2 mm. in diameter and from 6.6 mm. to 9.8 mm. in length. The form ratio for adults of the first varies from 1:2.1 to 1:2.7 and averages 1:2.3; of the second from 1:2.1 to 1:2.5 with an average of 1:2.3; of the third from 1:2.0 to 1:2.5 with an average of 1:2.2. Ontogenetic series of twenty specimens from the first sample, eighteen from the second, and eleven from the third show an increase of form ratio with growth:

STAGE	DIAMETER mm.	LENGTH mm.	FORM RATIO Variation	Average
First sample—				
Young	.6–1.9	1.3–4.0	1:1.6–1:2.2	1:2.0
Adult	2.1–3.0	5.0–7.0	1:2.1–1:2.7	1:2.3
Gerontic	2.5–3.6	7.8–8.6	1:2.4–1:2.8	1:2.6
Second sample—				
Young	1.0–2.3	2.1–5.0	1:1.9–1:2.2	1:2.1
Adult	2.8–3.9	6.5–8.7	1:2.1–1:2.5	1:2.3
Third sample—				
Young	1.9–3.0	3.9– 5.5	1:1.6–1:2.1	1:1.9
Adult	3.2–4.2	6.6– 9.8	1:2.0–1:2.5	1:2.2
Gerontic	5.0–5.1	10.7–11.0	....	1:2.2

It is difficult to designate the shape of the test which partakes of the characters described as fusoid, rhomboidal, ventricose, inflated, and even slightly obese in different individuals. The ends are broadly rounded to broadly pointed. The axis is straight. The lateral slopes vary from convex through straight to concave with, and even within the individual. The antetheca of specimens in the first and third samples is of even height from middle to ends; in the second the antetheca shows a very slight increase in height at the ends. In some specimens of the first sample septal furrows are rather deep, others shallow; in specimens of the second sample they are shallow; in those of the third sample they are flush.

Median section.—Adult specimens of the first sample have from six to eight and one-half volutions; those of the second sample from seven to eight; those of the third from seven and one-half to nine. The average heights of the successive volutions from the first to the last whorl of adult specimens of the first sample are .05, .07, .11, .15, .23, .28, .31, .34, .315 mm. The same series of measurements in specimens of the second sample are .045, .08, .12, .19, .28, .35, .31, .29 mm. In specimens of the third sample these average measurements are .075, .10, .14, .195, .26, .30, .335, .355, .395 mm.

The average number of septa per volution in specimens from the first sample from the innermost volution outward respectively are 14, 19, 22, 27, 28, 32, with individual variations of from 18 to 19 in the second whorl, 21 to 23 in the third, 24 to 29 in the fourth, 24 to 32 in the fifth, and 30 to 33 in the sixth. The septal counts in specimens of the second sample are 12, 17, 22, 24, 28, 32, 35, with individual variations of from 10 to 13 in the first whorl, from 20 to 24 in the third, 20 to 28 in the fourth, 24 to 32 in the fifth, 30 to 33 in the sixth, and 31 to 39 in the seventh. The septal counts in specimens of the third sample are 13, 20, 25, 27, 31, 32, 34, 39, with individual variations of from 11 to 14 in the first, 19 to 21 in the second, 24 to 25 in the third, 26 to 28 in the fourth, 30 to 32 in the fifth, 29 to 35 in the sixth, and no variation in the seventh and eighth.

The proloculum in specimens from the first sample varies from .15 mm. to .17 mm. in outside diameter; in specimens from the second sample from .12 mm. to .17 mm.; in specimens from the third sample the large proloculum varies from .22 mm. to .26 mm.

The average thicknesses of the wall in successive whorls from the first to the last respectively in specimens from the first sample are .02, .025, .03, .04, .06, .075, .10, .10, .10 mm. In specimens of the second sample the successive thicknesses are .02, .03, .04, .05, .07, .10, .11, .10 mm. In specimens of the third sample they are .02, .03, .05, .07, .09, .11, .12, .13 mm. The height of the chamber cavity in the last whorls for all specimens sectioned is approximately three times the thickness of the wall. The wall is composed of a thin tectum and a conspicuously alveolar keriotheca. In the later whorls of specimens of the first sample it has ten alveoli in .120 mm. to .170 mm. and averages ten in .140 mm. In specimens of the second sample ten alveoli occupy from .140 mm. to .200 mm., average ten in .170 mm. In specimens of the third sample ten alveoli occupy from .140 to .240 mm. and average ten in .180 mm.

The septa are like those of other species of the genus.

Axial section.—The fluting is moderate to obsolescent in the middle of the chambers of specimens of the first sample, and obsolescent in the middle of the chambers from specimens of the other two samples. The fluting is strong in the ends of all specimens from all three samples. The chomata are strong in all specimens from all three samples, except in the later whorls, where in some tests they are weak or even absent. The tunnel is visible from the outside of only very rare weathered specimens. The average tunnel angles in successive whorls from the first to the last whorl of specimens of the first sample are 13.5°, 16°, 17°, 22°, 24°, 26°, 29.5°, 32°, with individual variations of 10.5° to 16° in the first, from 10° to 22° in the second, from 15° to 22° in the third, from 16° to 31° in the fourth, from 18° to 30° in the fifth, 23° to 31° in the sixth, 28° to 32° in the seventh, and only one measurement of 32° for the eighth. In specimens of the second sample the successive tunnel angles average 16°, 16°, 16°, 18.5°, 26°, 33.5°, 39°, with individual variations of 11.5° to 19° in the first, 13.5° to 18° in the second, 12° to 20° in the third, 18° to 19.5° in the fourth, 19° to 31° in the fifth, 29° to 36.5° in the sixth, and 38.5° to 39° in the seventh. In specimens of the third sample these angles average 17.5°, 18.5°, 22°, 25.5°, 28°, 27°, 26°, with individual variations of 15.5° to 20° in the first, 17° to 20° in the second, 14° to 32° in the third, 18.5° to 38.5° in the fourth, 22° to 35° in the fifth, 24° to 32° in the sixth, and only one measurement of 26° for the seventh. Septal pores are fairly common and small.

Comparisons.—Under the varieties of the species the varieties are differentiated from the typical species. It is hardly likely that this species can be confused with any forms except its own varieties.

Figured specimens.—Bureau of Economic Geology Coll. Nos. 11841–11843 (first sample) and Nos. 11844–11846 (second sample) from Sta. 214–T–2; and Nos. 11847–11849 from Sta. 214–T–24.

TRITICITES VENTRICOSUS (Meek) var. INFLATUS Galloway and Ryniker, n.var. (ms.)

Pl. VII, figs. 10–12

Triticites ventricosus var. *inflatus* Galloway and Ryniker, manuscript on "Characters of Northern Mid-Continent Fusulinidae," and "Characters of Fusulinidae of the Mid-Continent Region."

Triticites ventricosus Dunbar and Condra (part), 1927, Nebr. Geol. Surv., Bull. 2, ser. 2, p. 84, pl. 4, figs. 5, 6 (not 1–4). (Nebraska.)

Material collected.—An abundance of tests of this varietal form have been collected from the Saddle Creek limestone, Harpersville formation, at the top of the hill about one mile south of the Lake Cisco dam and 2.8 miles by road from the Cisco depot on the Moran highway, Eastland County (Sta. 67–T–25).

Exterior.—Test is of medium size for the genus; adult forms are from 3.2 mm. to 4.3 mm. in diameter and from 7.3 mm. to 8.3 mm. in length. The form ratio for the adult specimens varies from 1:1.9 to 1:2.3 and averages 1:2.0. An ontogenetic series of thirteen specimens shows an increase of form ratio with growth:

STAGE	DIAMETER	LENGTH	FORM RATIO	
	mm.	*mm.*	Variation	Average
Young	1.4–3.1	2.0–5.9	1:1.4–1:2.0	1:1.8
Adult	3.2–4.3	7.3–8.3	1:1.9–1:2.3	1:2.0
Gerontic	4.4–4.5	8.9–9.1	....	1:2.0

The shape of the test is inflated or ventricose with broadly to obtusely pointed ends, straight axis, and convex lateral slopes. The antetheca is of even height from the middle to the ends. The septal furrows are flush to shallow.

Median section.—Sectioned adult specimens show from seven and one-half to nine volutions. The average heights of the successive volutions from the first to the ninth whorl are .08, .10, .13, .17, .23, .28, .32, .36, .33 mm. The average number of septa per volution from the first to the eighth whorl are 12, 21, 25, 27, 28, 35, 38, 33, with individual variations of 11 to 13 in the first, 24 to 26 in the third, 25 to 30 in the fifth, and 34 to 36 in the sixth, only one count having been made for the seventh and eighth. The proloculum is large, varying from .24 mm. to .28 mm. in outside diameter. The average thicknesses of the wall in successive whorls from the first to the ninth respectively are .03, .04, .05, .06, .08, .08, .10, .11, .115 mm. The height of the chamber cavity in the last whorls is approximately three times the thickness of the wall. The wall is composed of a thin tectum and a coarse consipcuously alveolar keriotheca, which has ten alveoli in .180 mm. to .220 mm. and averages ten in .190 mm., as measured in the later whorls.

The septa are like those of other species of the genus.

Axial section.—The fluting is moderate in the middle and strong in the ends of the chambers. Chomata are strong throughout most tests but may be weak in the last whorl. The tunnel is often visible from the outside of weathered specimens. The average tunnel angles from the first to the eighth whorl successively are 14°, 14°, 16°, 17.5°, 24°, 24°, 32.5°, 38°, with individual variations of 12° to 17° in the first, 10.5° to 16.5° in the second, 13.5° to 19.5° in the third, 15.5° to 21° in the fourth, 23° to 26° in the fifth, 20° to 30.5° in the sixth, 28° to 38° in the seventh, 26° to 44° in the eighth. Septal pores are relatively few and small.

Comparisons.—This variety of the species differs from the typical species and from its other varieties in its more gibbous form expressed by a lower form ratio, a greater amount of fluting across the middle of the chambers; and somewhat stronger chomata. This variety of the species can easily be confused with *Triticites consobrinus* Galloway and Ryniker n.sp. (ms.) with which it is compared under the description of the latter species.

Figured specimens.—Bureau of Economic Geology Coll. Nos. 11850–11852 from Sta. 67–T–25. Cotypes of this manuscript variety will be described later from the northern part of the Mid-Continent area.

TRITICITES VENTRICOSUS (Meek) var. MEEKI (Möller)

Pl. VII, figs. 13–15

Fusulina cylindrica var. *ventricosa Meek* (part), 1858, Proc. Acad. Nat. Sci. Philadelphia, vol. 10, p. 261.

Fusulina cylindrica Meek and Hayden (part), 1865, Pal. upper Missouri, Smithsonian Contrib. to Knowledge, vol. 14, p. 14, pl. 1, figs. 6a–c (not 6e–g), so selected by Möller.

Fusulina ventricosa var. *Meeki* Möller, 1879, Mém. Acad. Impér. Sci. St. Pétersbourg, ser. 7, vol. 27, no. 5, p. 5.

Triticites ventricosus Dunbar and Condra (part), 1927, Nebr. Geol. Survey Bull. 2, ser. 2, p. 84, pl. 4, fig. 4. (Nebraska.)

Material collected.—An abundance of tests of this varietal form have been collected from a shale bed about 75 feet above the upper Gunsight limestone ledge and about 20 feet below the Ivan limestone in the second escarpment along the Ivan-Breckenridge highway about two and one-half miles southwest of Ivan, Stephens County (Sta. 214–T–2). In the same bed *Triticites ventricosus* (Meek) and *T. beedei* Dunbar and Condra are abundant.

Exterior.—Test is fairly large for the genus; adult forms are from 2.0 mm. to 3.0 mm. in diameter and from 5.1 mm. to 9.2 mm. in length. The form ratio for the adult specimens varies from 1:2.3 to 1:3.1 and averages 1:2.7. An ontogenetic series of twenty specimens shows a rather rapid increase of form ratio with growth:

STAGE	DIAMETER	LENGTH	FORM RATIO	
	mm.	*mm.*	Variation	Average
Young	1.0–1.9	2.2– 4.4	1:2.1–1:2.4	1:2.3
Adult	2.0–3.0	5.1– 9.2	1:2.3–1:3.1	1:2.7
Gerontic	2.9–3.0	10.5–11.5	1:3.6–1:3.8	1:3.7

The shape of the test is fusiform to somewhat ventricose with bluntly pointed ends, straight axis, and lateral slopes that vary from concave through straight to slightly convex with, and even in, the individual. The antetheca is of even height throughout most of its extent, but close to the ends it becomes slightly higher.

The septal furrows are not deep but distinct.

Median section.—The sectioned adult specimens show from six and one-half to seven and one-half volutions. The average heights of the successive volutions from the first to the last whorl are .05, .09, .14, .22, .29, .29+, .31 mm. The average number of septa per volution in successive whorls from the first to the sixth are 11, 16, 19, 22, 24, 26, with individual variations of 9 to 13 in the first, 14 to 18 in the second, 17 to 20 in the third, 20 to 23 in the fourth, 21 to 26 in the fifth, and no variation noted in the sixth. The proloculum varies from .14 mm. to .24 mm. in outside diameter. The average thicknesses of the wall in successive volutions from the first to the eighth respectively are .02, .03, .04, .06, .08, .09, .12, .11 mm. The height of the chamber cavity in the last whorls is about three times the thickness of the wall. The wall is composed of a thin tectum and a conspicuously alveolar keriotheca, which has ten alveoli in .140 mm. to .180 mm. and averages ten in .160 mm., as measured in the later whorls.

The septa are similar to those of the other species of the genus.

Axial section.—The fluting is obsolescent to moderate in the middle of the chambers and strong at the ends. The chomata are strong except in the last whorl where they are weak or even absent. The tunnel is only faintly visible on the outside of crushed specimens. The average tunnel angles from the first to the sixth whorl successively are 20°, 25°, 30°, 34°, 27°, 32.5°, with individual variations of from 16° to 30° in the first, 21° to 30° in the second, 24° to 34° in the third, 27° to 41° in the fourth, 23° to 34° in the fifth, and 29° to 40.5° in the sixth. Septal pores are few and small.

Comparisons.—This variety of the species is much slimmer and is therefore characterized by a higher form ratio than other forms of the species. It is similar to *Triticites secalicus* (Say) but has a more slender shape, a more uniform height of antetheca, higher volutions, thicker walls, larger proloculum, much narrower tunnel, and coarser alveolar wall structure.

Figured specimens. — Bureau of Economic Geology Coll. Nos. 11853–11855 from Sta. 214–T–2.

TRITICITES sp. A

Pl. VIII, figs. 1–3

Material collected.—Specimens of this rare form have been collected from the top of the East Mountain shale member of the Mineral Wells formation just below the Lake Pinto sandstone one mile in a direct line northeast of Mineral Wells, Palo Pinto County (Sta. 181–T–79). *Triticites irregularis* (Schellwien and Staff), fourth form, is also rare in this same layer.

Only five poorly preserved specimens of this form have been available for study, and of these but one was full grown. Two were sectioned, the others not being fit to section. It is probable that this form is new, but the insufficient number of specimens makes this conclusion somewhat questionable. As it is one of the two earliest forms of *Triticites* found in the Texas geologic section, it is thought best to record it.

Exterior.—The largest specimen is of medium size for the genus, measuring 3.3 mm. in diameter and 7.3 mm. in length, having a form ratio of 1:2.2. The following table shows the size and form ratio of the five specimens:

DIAMETER	LENGTH	FORM RATIO	
mm.	*mm.*	Variation	Average
2.4–3.3	4.2–7.3	1:1.9–1:2.3	1:2.1

The shape of the test is rhomboidal with broadly pointed ends, straight axis, and straight to concave lateral slopes. The antetheca is slightly higher at the ends than in the middle. Septal furrows are shallow.

Median section.—The thin sections show from six and one-half to eight and one-half volutions. The average heights of the successive volutions from the first to the eighth are .075, .08, .14, .175, .255, .285, .295, .235 mm. The last figure is inaccurate due to deformation of the test. The average number of septa per volution from the first to the fifth respectively are 12, 17, 20, 21, 22. The outside diameters of the proloculi of the two specimens measured are .195 mm. and .220 mm. The average thicknesses of the wall in successive volutions from the first to the eighth respectively are .02, .02, .03, .035, .05, .06, .08, .085 mm. The height of the chamber cavity in the first two whorls is about four times the thickness of the wall, in the third to sixth inclusive about five times the thickness of the wall, in the seventh less than four times. The wall is composed of a thin tectum, an alveolar keriotheca, and what appears to be a rather heavy outer depositional layer also. The spacing of the alveoli in successive whorls from the inner to the outer changes more rapidly than is usual. The alveolar structure is coarser in the outer walls than would be expected in a form so stratigraphically low. In the next to the last whorl the wall shows ten alveoli in .150 to .170 mm. and averages ten in .165 mm. In the wall of the antepenultimate whorl ten alveoli occupy a space of .130 mm. to .140 mm. and average ten in .135 mm.

The septa are like those in other forms of the genus.

Axial section.—The fluting is moderate in the middle of the chambers and strong in the ends. The chomata are massive throughout and show very clearly the characteristic layer-on-layer structure. Some chomata are double or form a double mound. From the chomata to the ends of the chambers and also between the chomata is a deposit of material lacking the structure of the chomata. The chomata are prominent on the outside of weathered specimens. The average tunnel angles from the first to the seventh whorl successively are 10.5°, 11.5°, 11.5°, 15.5°, 19°, 20°, 25.5°. Only one angle of 17° could be measured for the eighth whorl. The tunnel angles vary from 9° to 12° in the first whorl, 11° to 12° in the second, 9° to 14° in the third, 14° to 17° in the fourth, 17° to 21° in the fifth, 19° to 20.5° in the sixth, and 24° to 27° in the seventh. No septal pores were observed.

Comparison. — This form resembles to some extent *Triticites obesus* (Beede), with which it is not likely to be confused. It has greater height of volutions, a larger proloculum, more pronounced chomata, and an outer depositional layer in the wall structure.

Figured specimens. — Bureau of Economic Geology Coll. Nos. 11856–11858 from Sta. 181–T–79.

TRITICITES sp. B

Pl. VIII, figs. 4–6

Material collected.—Specimens of this rare form have been collected from the contact of the Gonzales Creek shale and the Bunger limestone, Graham formation, at the junction of a small creek and Brazos River about half a mile downstream from the bridge on the Graham-South Bend road, Young County (Sta. 251–T–26).

Exterior.—This small test ranges from .3 mm. to .9 mm. in diameter and from .3 mm. to 1.4 mm. in length. They are all very young specimens. The form ratio varies from 1:1.0 to 1:1.6 and averages 1:1.4. An ontogenetic series of seventeen tests was examined and many more were available. The shape of the test is globular with broadly rounded ends, straight axis and convex lateral slopes. The antetheca is of even height throughout in some tests, and in others it is slightly higher at the ends. Septal furrows are flush and indistinct.

Median section.—The thin sections show from three to four and one-half whorls. The average heights of the successive volutions from the first to the fourth are .04, .06, .09, .15 mm. The septal count has been difficult to obtain but averages 11, 16, 20 for the first, second, and third whorls, with individual variations of 10 to 11 in the first and 15 to 16 in the second. The proloculum measures from .105 mm. to .130 mm. in outside diameter. The average thicknesses of the wall in successive volutions from the first to the last are .01, .015, .02, .03, .035 mm. The height of the chamber cavity in the last whorls is from four and one-half to five times the thickness of the wall. The wall is composed of a thin tectum and an alveolar keriotheca, which has ten alveoli in .090 mm. to .110 mm. and averages ten in .105 mm.

The septa are like those of other species of the genus.

Axial section.—Fluting is obsolescent through the middle and moderate in the ends of chambers. The chomata are strong up to the last whorl, where they are absent. The average tunnel angles for both the first and second whorl are 35°, with individual variations of 30° to 46° in the first and 32° to 38° in the second. Septal pores are numerous and very small.

Comparison.—The specimens are too young to place specifically and may be of little or no value. Because of their size and shape they can easily be confused with *Schubertella.* However, they are obviously not a species of *Schubertella,* because they lack the endothyroid beginning and have the typical triticitian wall.

Figured specimens.—Bureau of Economic Geology Coll. Nos. 11859–11861 from Sta. 251–T–26.

SCHWAGERINA Möller, 1877

SCHWAGERINA FUSULINOIDES Schellwien

Pl. VIII, figs. 10–12

Schwagerina fusulinoides Schellwien, 1892, Paleontographica, vol. 39, p. 259, pl. 21, figs. 1–4, 8.
Schwagerina fusulinoides, Beede and Kniker, 1924, Univ. Texas Bull. 2433, p. 19, pl. 1, fig. 4; pl. 3, figs. 1–4, 8; pl. 7, figs. 1–3. (Texas.)
Schwagerina fusulinoides, Dunbar and Condra, 1927, Nebr. Geol. Survey Bull. 2, ser. 2, p. 121, pl. 14, figs. 1–4. (Texas.)

Material collected.—Specimens of this species have been collected by Fielding Bohart from an ant-hill at Gap Tank, Glass Mountains, Pecos County (Sta. 185–T–3).

Exterior.—Nine adult specimens available for study range from 2.2 mm. to 3.4 mm. in diameter and from 4.4 mm. to 7.1 mm. in length. The form ratio varies from 1:2.0 to 1:2.4 and averages 1:2.1. Individual tests show much variation in size and form ratio; consequently averages of measurements in three thin sections have been made and those in a fourth are recorded separately. This variation, however, is not so marked as Beede has stated.

The shape is in general ellipsoid but varies enough to be both fusiform and ventricose. The ends are broadly rounded, and the axis straight. Lateral slopes are convex. The antetheca is of uniform height from the middle of the chambers to the ends. Septal furrows are shallow.

Median section.—The thin sections show from six to seven whorls. The average heights of the successive volutions from the first to the seventh respectively for three of the thin sections are .04, .05, .09, .14, .24, .41, .44 mm.; in a fourth section these measurements are .07, .11, .18, .30, .47, .50 mm. The average number of septa per whorl from the first to the seventh successively are 9, 14, 19, 20, 23, 26, 24, with individual variations of from 8 to 10 in the first, 11 to 17 in the second, 16 to 22 in the third, 18 to 22 in the fourth, 18 to 28 in the fifth, 22 to 29 in the sixth, and a single reading of 24 in the seventh. The average thicknesses of the wall in successive whorls from the first to the seventh whorl for three of the sections are .01, .02, .025, .03, .05, .07, .07 mm. In a fourth section these thicknesses are .02, .03, .04, .04, .05, .065 mm. The proloculi of the three sections are .10 mm., .10 mm., .12 mm. in outside diameter, and that of the fourth .26 mm. In one specimen the height of the chamber cavity in the fourth whorl is as much as seven and one-half times the thickness of the wall; in the others, seven times. The wall is composed of a thin tectum and a conspicuously alveolar keriotheca, which has ten alveoli in .160 mm. to .200 mm. and averages ten in .190 mm., as measured in the last whorls of three of the sections. In the fourth section ten alveoli occupy .210 mm. to .220 mm. and average ten to .220 mm.

The septa are typical of *Triticites* in the early and more closely coiled whorls, thinner, longer, and more wavy in the later, higher whorls.

Axial section.—The fluting is quite strong throughout, but chomata are practically confined to the proloculum. A few septal pores are present in the last whorls.

Comparison.—This form shows stronger fluting than *Schwagerina uddeni* Beede and Kniker, has a smaller proloculum, a larger number of volutions, and a more slender test, in which the expansion of the chamber cavity occurs gradually through the third and fourth volutions instead of suddenly in the third.

Figured specimens. — Bureau of Economic Geology Coll. Nos. 11865–11867, from Sta. 185–T–3.

SCHWAGERINA GIGANTEA, M. P. White, n.sp.

Pl. VIII, figs. 13–15

Material collected.—Very few specimens have been made available for study by M. E. Upson from the lower Wolfcamp formation at its type locality about one mile west of the Ramsey (old Taylor) ranch house and north of Wolf Camp, Brewster County (Sta. 22–T–139). In these same strata *Triticites longissimoideus* (Beede) and *Schwagerina uddeni* Beede and Kniker occur.

Exterior.—Six adult specimens have been available in the study of this species, and of these three were sectioned. The test is very large; the diameter varies from 4.3 mm. to 5.3 mm., the length from 11.3 mm. to 15.0 mm., and the form ratio from 1:2.5 to 1:3.4, averaging 1:2.8.

The shape is fusoid with bluntly pointed ends, straight axis, and gently convex lateral slopes. The antetheca is of even height from middle to ends. The septal furrows are rather deep.

Median section.—The thin sections show from nine to ten whorls. The average heights of the successive volutions from the first to the tenth respectively are .03, .04, .065, .12, .25, .425, .505, .49, .41, .43 mm. The number of septa per whorl from the first to the eighth whorl in one section are 17, 18, 20, 24, 25, 27, 39, 45. The average thicknesses of the wall in successive whorls from the first to the tenth whorl respectively are .01, .015, .02, .03, .03, .05, .07, .08, .08, .09 mm. The minute proloculum measures in outside diameter .07 mm. in two thin sections and .06 mm. in the third. The height of the chamber cavity in the fifth whorl is over eight times the thickness of the wall, is about the same in the sixth, and becomes gradually only about five times the wall thickness in the last whorls. The wall is composed of a thin tectum and a coarse conspicuously alveolar keriotheca, which has ten alveoli in .180 mm. to .220 mm. and averages ten in .195 mm., as measured in the last whorls.

The septa are like those of *Triticites* in the early closely coiled whorls; they are longer, thinner, and more wavy in the higher volutions; and they become more typically triticitian in the last volution.

Axial section.—The fluting is strong throughout. Chomata are developed in only the first two to three whorls. It is difficult to measure the tunnel angle because of its small size and the poor development of the chomata. A few small septal pores were observed in the last whorl of one of the sections.

Comparison.—The great size of the test, minute proloculum, large number of volutions, strong fluting, and the delayed increase of the chamber cavity till the fifth whorl will serve to differentiate this from other known *Schwagerinae.*

Cotypes.—Bureau of Economic Geology Coll. Nos. 11868–11870 from Sta. 22–T–139.

SCHWAGERINA UDDENI Beede and Kniker

Pl. VIII, figs. 16–18

Schwagerina uddeni Beede and Kniker, 1924, Univ. Texas Bull. 2433, p. 27, pl. 1, figs. 1, 2; pl. 4, fig. 10; pl. 6, figs. 1, 2, 4–7. (Texas.)
Schwagerina uddeni Dunbar and Condra, 1927, Nebr. Geol. Surv., Bull. 2, ser. 2, p. 119, pl. 13, figs. 1–3. (Texas.)

Material collected.—Only very few specimens of this species have been made available by M. E. Upson from the lower Wolfcamp formation at its type locality about one mile west of Ramsey (old Taylor) ranch house and north of Wolf Camp, Brewster County (Sta. 22-T-139). In these same strata *Triticites lognissimoideus* (Beede) and *Schwagerina gigantea* M. P. White n.sp. occur.

Exterior.—Only four specimens of this species have been available for study, and all are of the more elongate form of the species. The diameter is 4.0 mm. to 5.7 mm., and the length 7.6 mm. to 12.0 mm. The form ratio ranges from 1:1.9 to 1:2.1 and averages 1:2.0.

The shape is ventricose to inflated with broadly rounded ends, straight axis, and convex lateral slopes. The antetheca is of even height from the middle to the ends of the chambers. Septal furrows are shallow.

Median section.—Specimens from which the three thin sections were made show five to five and one-half volutions. The average heights of the successive volutions from the first to the last respectively are .11, .16, .30, .685, .66, .45 mm. The average number of septa per whorl is somewhat high without the usual lag and averages 15 for the first, 21 for the second, 22 for the third, 25 for the fourth, and 35 for the fifth, with individual variations of 14 to 17 in the first, 23 to 27 in the fourth, and 30 to 40 in the fifth. The average thicknesses of the wall in successive whorls from the innermost whorl outward are .05, .055, .07, .085, .13, .13 mm. The large proloculum measures in the three sections .30 mm., .36 mm., and .38 mm. The height of the chamber cavity in the fourth whorl, where it is largest, is about eight times the thickness of the wall. The wall is composed of a thin tectum and a conspicuously coarsely alveolar keriotheca, which has ten alveoli in .160 to .260 mm. and averages ten to .200 mm., as measured in the last whorls.

The septa are typical of *Triticites* in the early closely coiled whorls, but they are thinner, longer, and more wavy in the later whorls.

Axial section.—The fluting is weak through the middle and moderate in the ends of the chambers. Chomata are observed to the third whorl on one side of the test and only to the first on the other. The tunnel angle of the first whorl is 14° and 25°, of the second 29°, and of the third 41°. Septal pores have not been observed.

Comparison.—The few whorls, enormous proloculum and sudden increase of height after the second volution, serves to differentiate this from any other form.

Figured specimens.—Bureau of Economic Geology Coll. Nos. 11871–11873 from Sta. 22–T–139.

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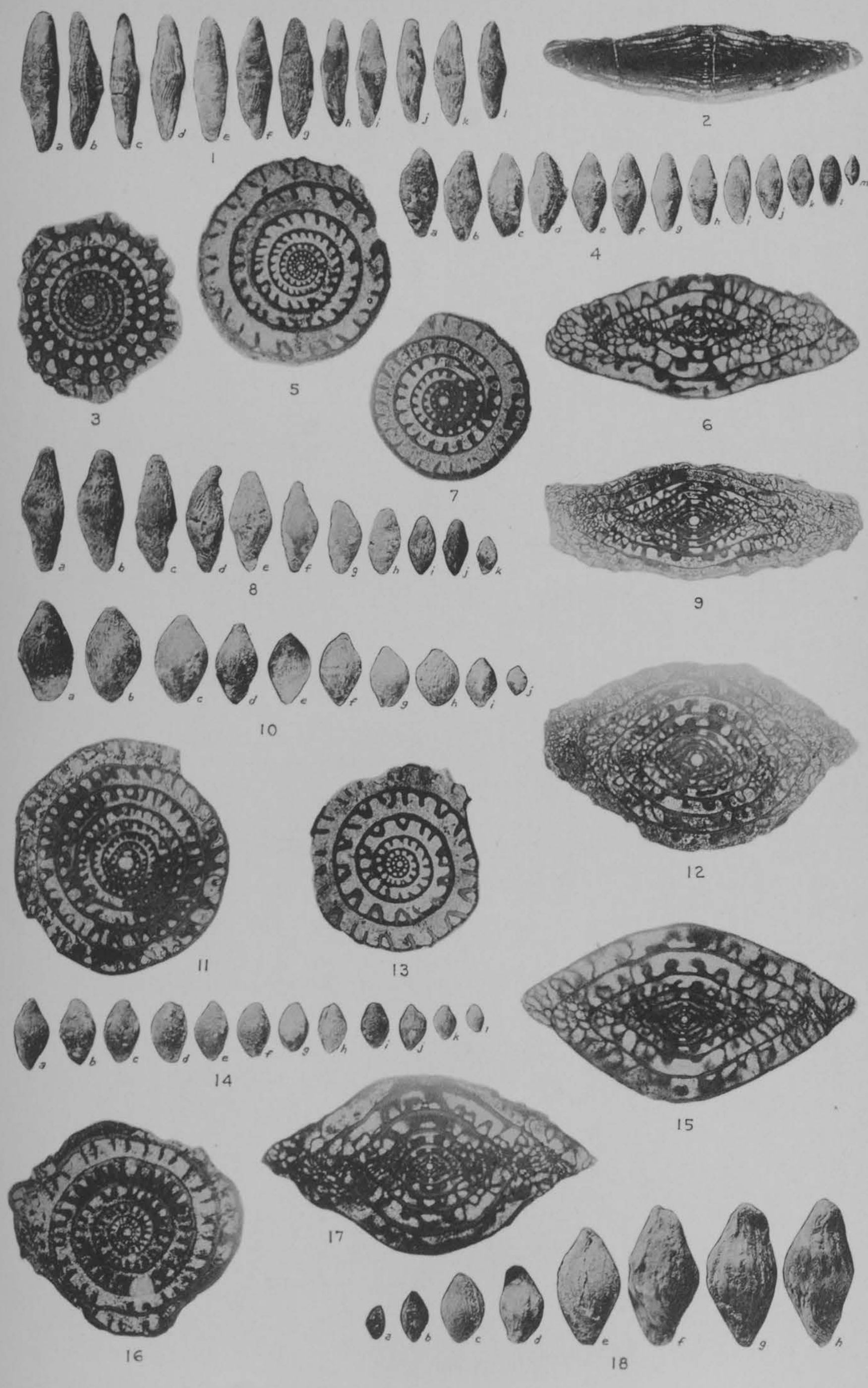
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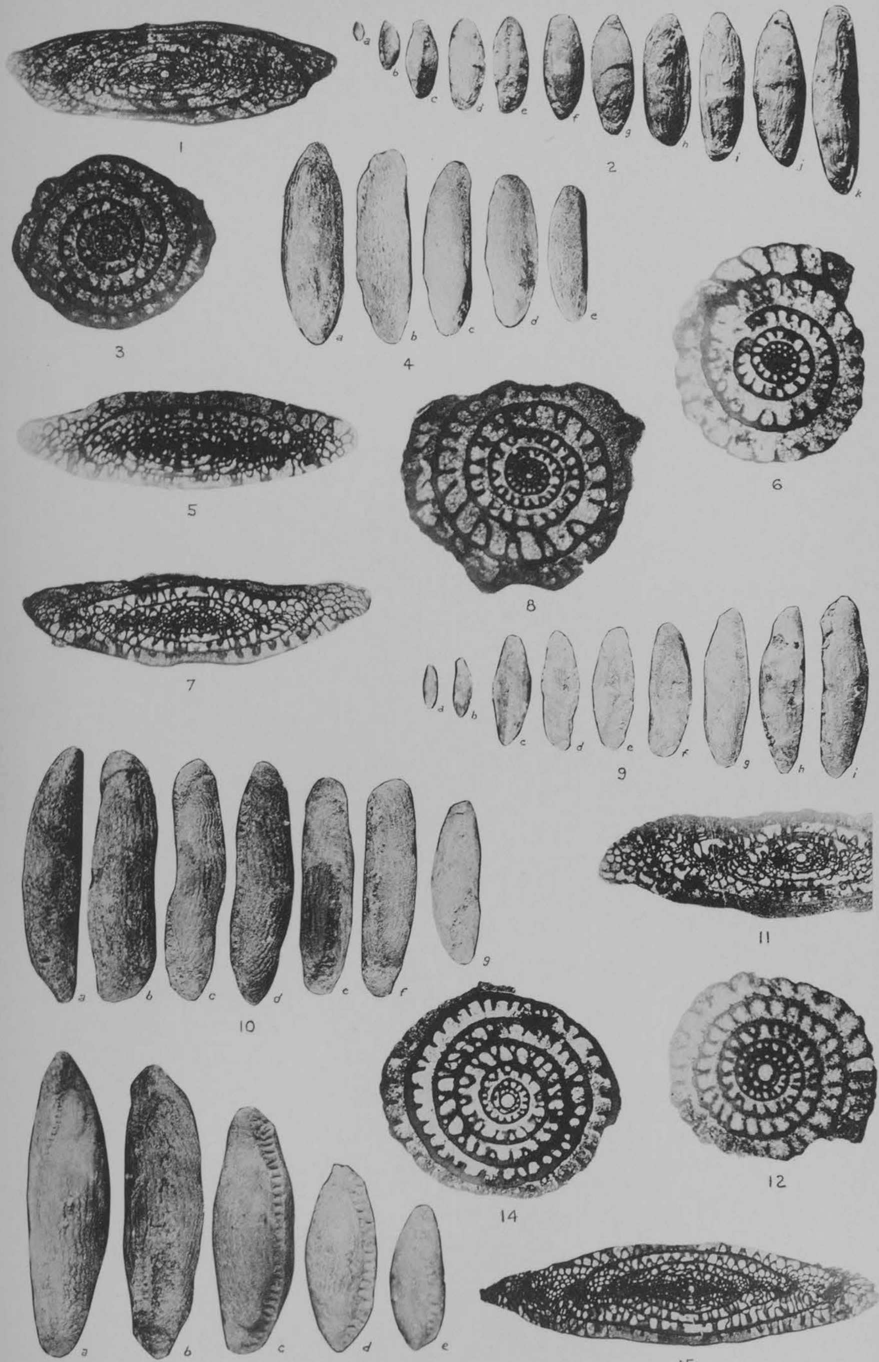
PLATE II

PLATE III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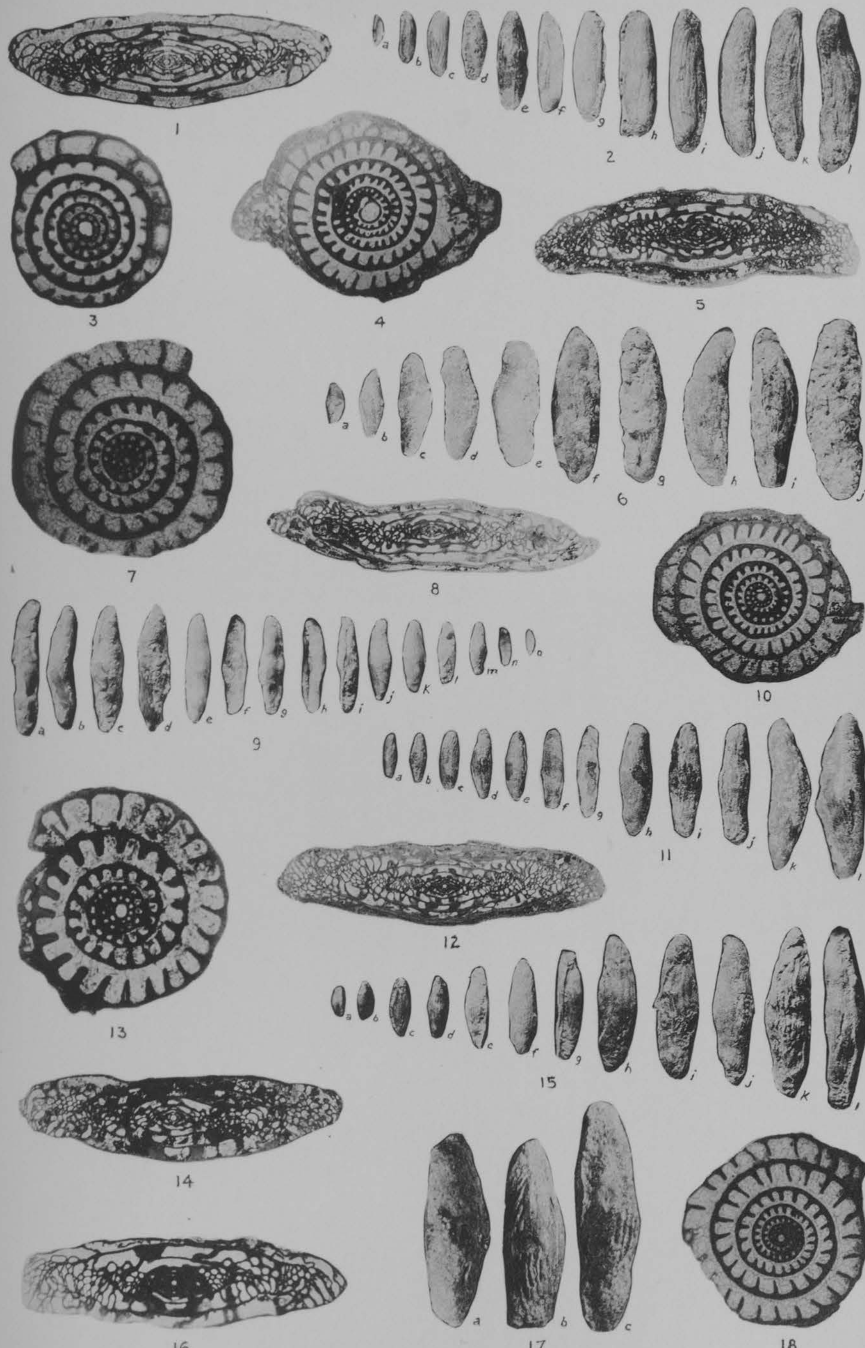
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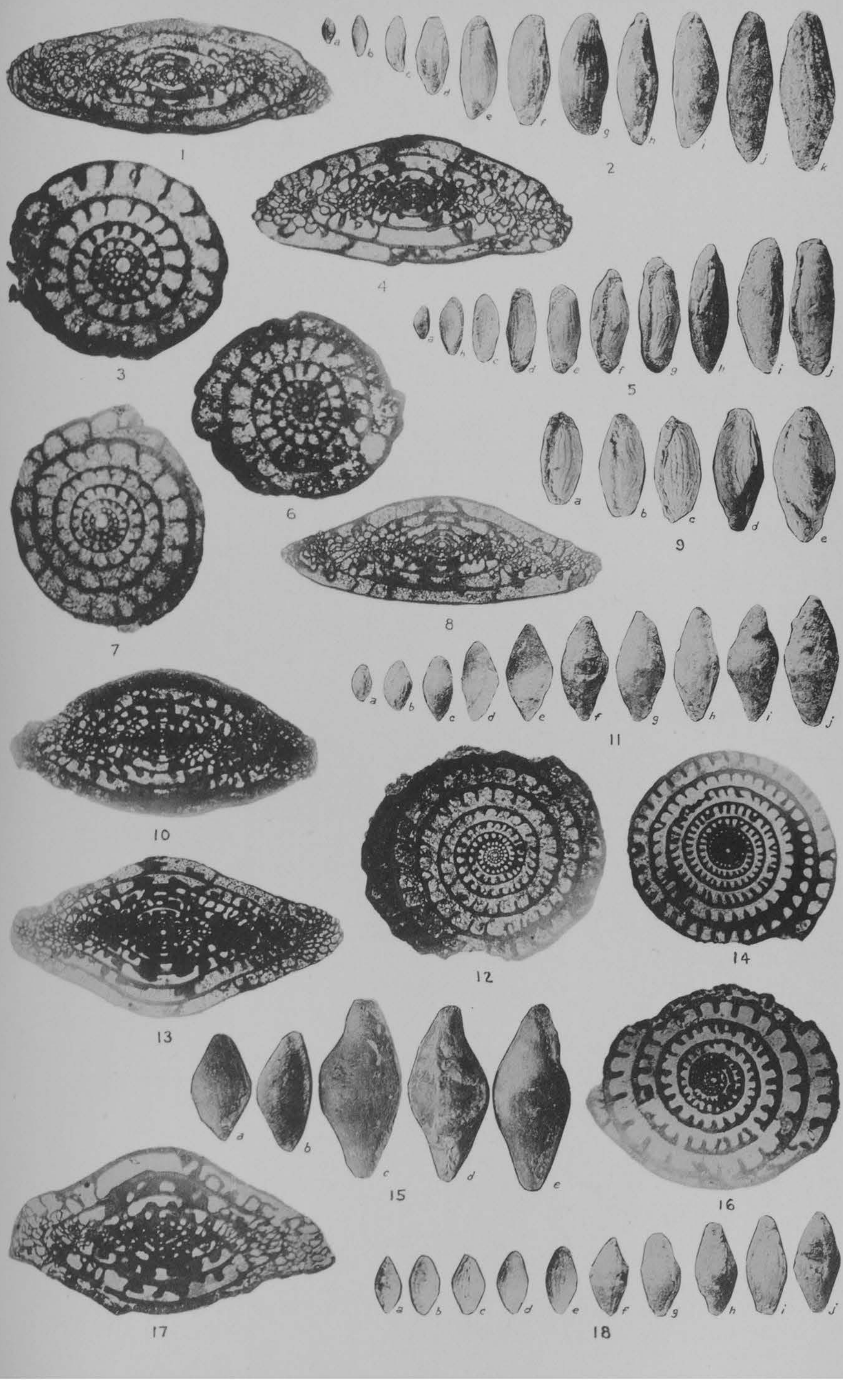
18. Ontogenetic series, probably dwarfed, young to gerontic (*a–j*); ×2.8.



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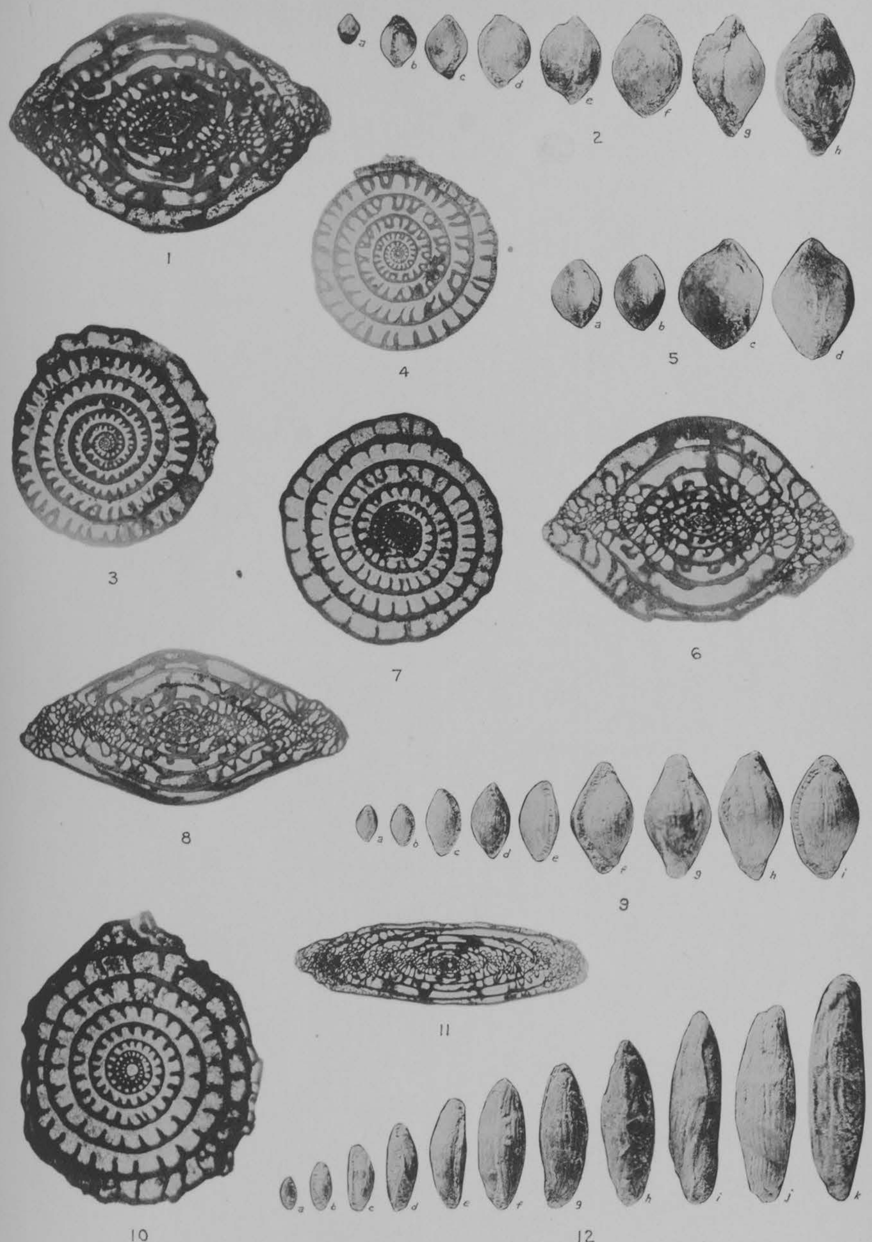

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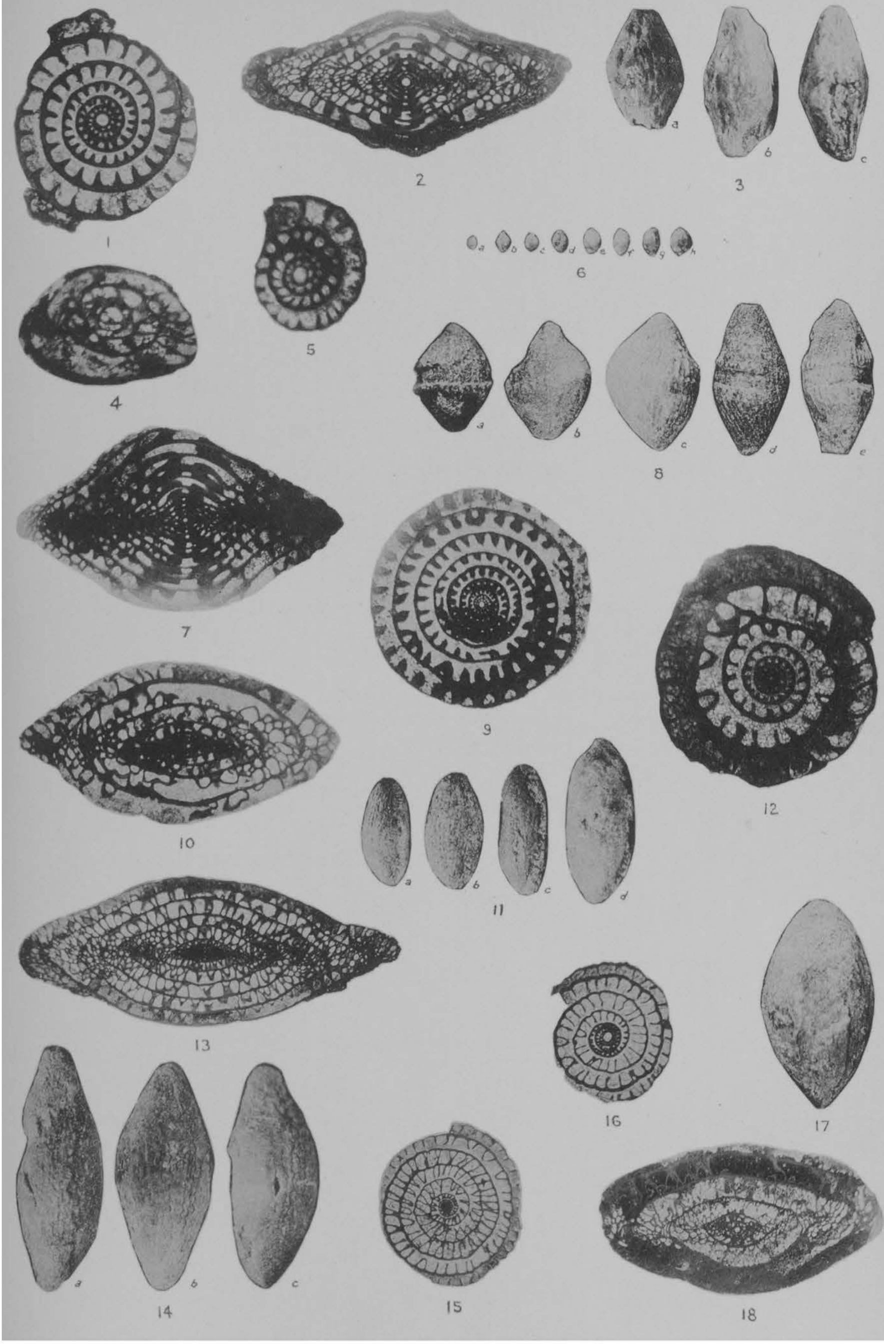
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PLATE IX

1. Small portion of the exterior surface of an adult specimen; $\times 32$. The stipled appearance is due to the open ends of thousands of tubes penetrating the wall, thus showing its perforate character.
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4. Thin section showing the existence of fibers penetrating all four layers of the wall, including the chomata; $\times 51$.
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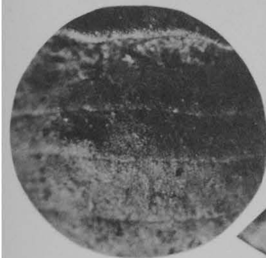
(Photographs taken by Dr. Marcus Hanna)



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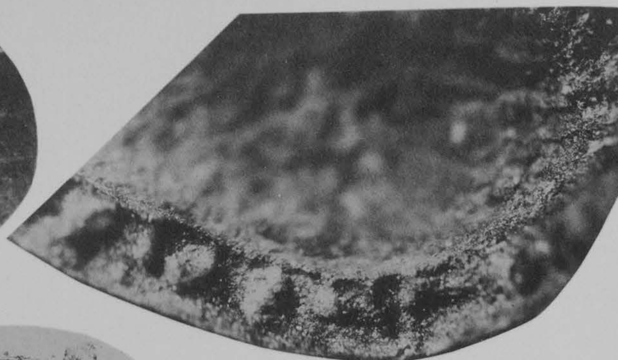

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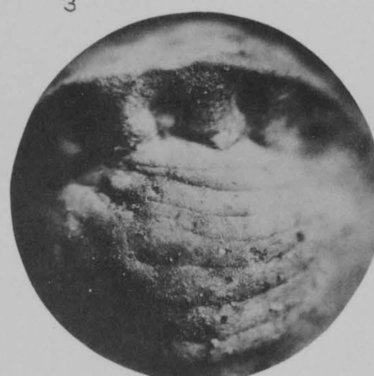

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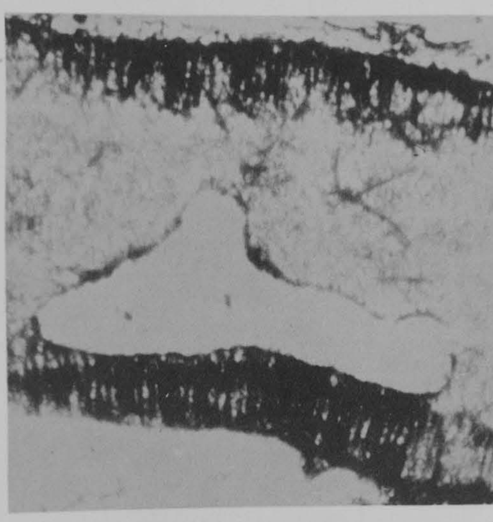

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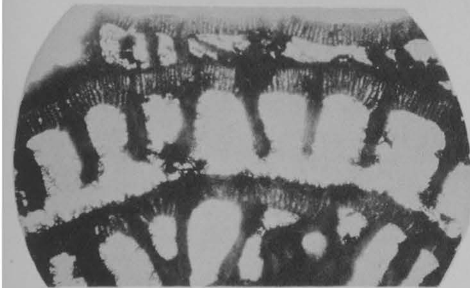
4. Smaller portion of the above section showing the antetheca and last septum, $\times 325$. Loss of definition by higher magnification almost obscures the detail, even the pores.

(Photographs taken by Dr. Marcus Hanna)



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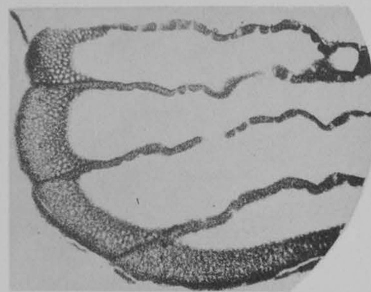

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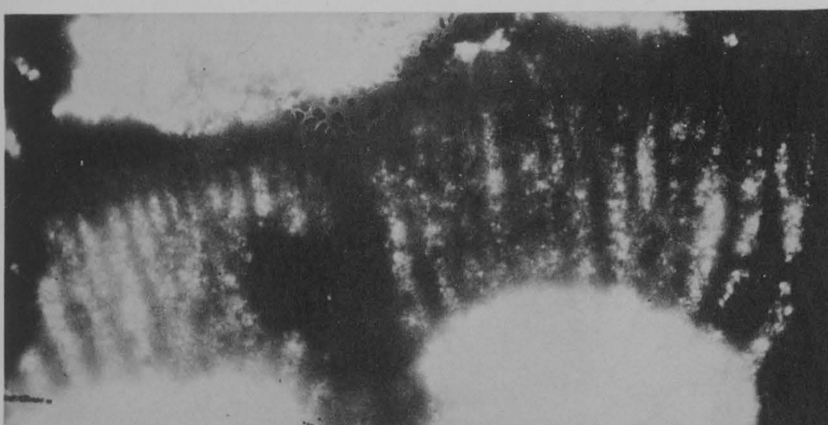

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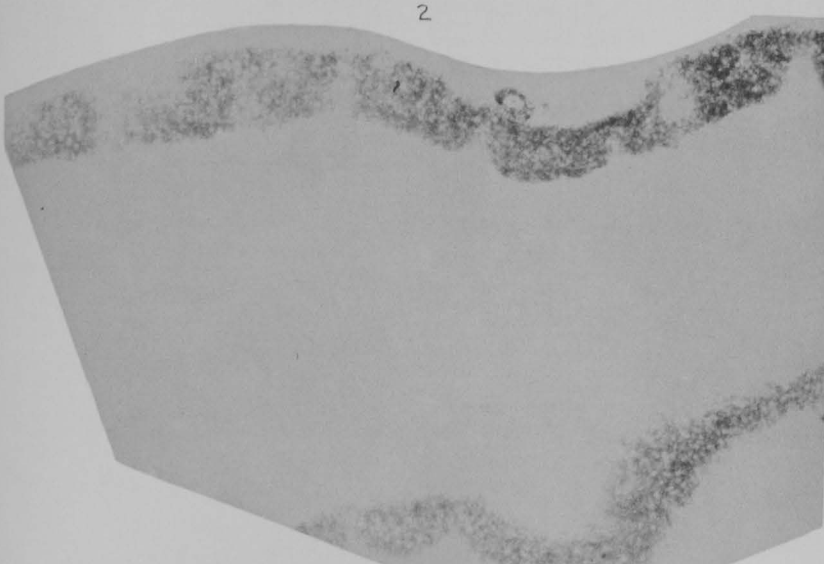

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